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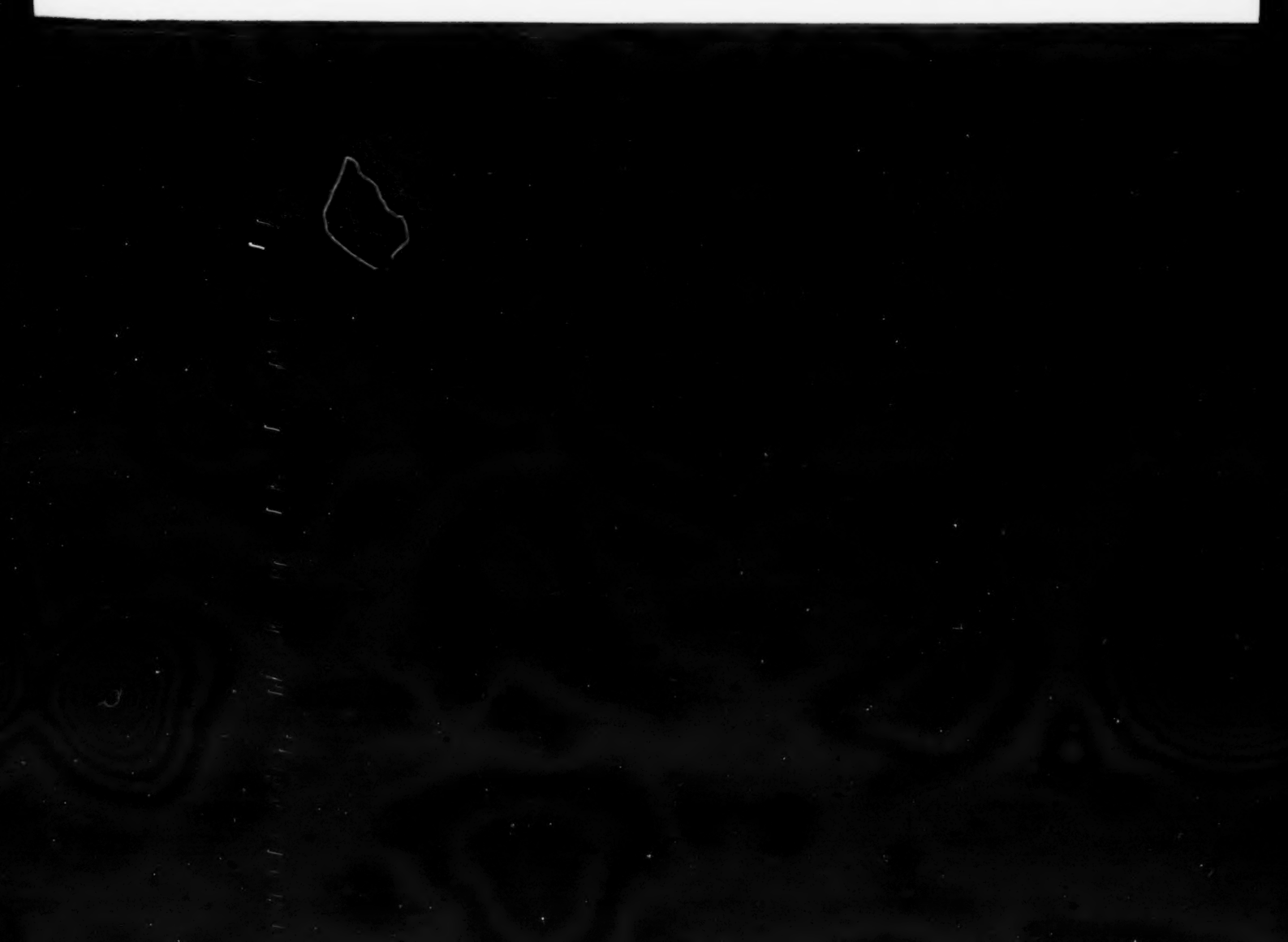

THE

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INDUSTRIAL DEVELOPMENT OF THE SOUTH.

By Richard H. Edmonds.

I.—ENTERPRISE BEFORE THE WAR.

IF the South has such great natural resources as its friends claim, and if it is destined to become the seat of such vast industrial interests as is predicted, why did it not develop its manufactures before 1860? And after the war why did it wait for Northern energy and capital to come down and begin the present era of industrial progress? These questions are frequently asked, and often by men who ought to know the history of their country better than such questions would indicate. The Southern States from the time of their first settlement until 1860 devoted far more attention to manufacturing interests than they have ever received credit for. In later years, instead of waiting for Northern energy, Southern men led the way in industrial development and demonstrated to the world the possibilities of their section. Then outside capital came in to aid in the building of factories, the opening of mines, and the construction of railroads.

In the Southern colonies iron-making became an important industry, even before the beginning of the eighteenth century. The first settlers in Maryland, Virginia, the Carolinas, Tennessee, Alabama, and Georgia early turned their attention to this business. Considerable progress was made in all of these States, and the old-time furnaces and forges produced large quantities—at least large for those days—of high-grade iron. Referring to the development of iron-making in the Southern colonies, Mr. James M. Swank, in his "History of Iron in All Ages," says that the estab-

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lishment at an early day of so many charcoal furnaces and bloomeries is an interesting fact in the iron history of our country. "The people who built these furnaces and bloomeries," he adds, "were not only bold and enterprising, but they appear to have been born with a genius for making iron. Wherever they went they seem to have searched for iron-ore, and, having found it, their small charcoal furnaces and bloomeries soon followed. No States in the Union have shown in their early history more intelligent appreciation of the value of an iron industry than North Carolina and Tennessee, and none have been more prompt to establish it. The enterprise of these early iron-workers assumes a picturesque aspect when viewed in connection with the primitive methods of manufacture which were employed by them. . . . They were pioneers and frontiersmen in every sense; from the great world of invention and progress they were shut out by the mountains and streams and hundreds of miles of unsubdued forest. . . . It is a curious fact that the daring men who pushed their way into the wilds of western Carolina and east Tennessee in the last century, and who set up their small furnaces and bloomeries when forts yet took the place of hamlets, founded an iron industry which still retains many of the primitive features that at first characterized it."

Such were the pioneer iron-men of the South. In many cases they were the leading citizens of the colonies. As early as 1716 Governor Spotswood of Virginia established several iron-making enterprises, and in 1727 the General Assembly of that State passed "an act for encouraging adventurers in iron-works." Colonel William Byrd of Westover, Va., writing in 1732 of the many iron enterprises that had been started, gives some particulars of a number of them, including "England's iron mines, called so from the chief manager of them, tho' the land belongs to Mr. Washington." Quoting from these writings Mr. Swank says these mines were on the north side of the Rappahannock river, "not far from a spring of strong steel water" which was in King George county, twelve miles distant from Fredericksburg. Two miles distant from the mines was a furnace. "Mr. Washington raises the ore and carts it thither for 20 shillings the ton of iron that it yields. . . . Besides Mr. Washington and Mr. England, there are several other persons in England concerned in these works. Matters are very well managed there, and no expense is spared to make them profitable." The "Mr. Washington" referred to was, says Mr. Swank, Augustine Washington, father of George Washington.

After giving in detail the history of the many iron-works started in Virginia, Mr. Swank says: "About 1790 the iron industry of Virginia took a fresh start, as did many other manufactures of the State. This activity continued for many years, but it was partly checked in subsequent years by the greater attention given by the people of Virginia to agricultural pursuits. No State in the Union gave more attention to domestic manufactures after the close of the Revolution than Virginia. Richmond, Lynchburg, Staunton, Winchester, and some other places became noted for the extent and variety of their manufactures. Household manufactures were also everywhere cultivated. The manufacture of nails was one of these industries. Thomas Jefferson required about a dozen of the younger slaves owned by him to make nails, and it is said that "they made about a ton of nails a month at a considerable profit." Lesley gives the names of 88 charcoal furnaces and 59 forges and bloomeries and 12 rolling-mills built in Virginia prior to 1856. So general was the interest in iron-making that these furnaces were located in thirty-one counties and the forges in twenty-five.

In South Carolina iron-making was not commenced at so early a date as in Virginia, but iron-works were built in 1773. At the beginning of the Revolution the State offered liberal premiums to those who would establish iron-works. Like Virginia and North Carolina, this State has some very rich iron ores, and in York and adjoining counties a number of furnaces and rolling-mills were established, and in 1810 there were among other enterprises a steel furnace and a nail mill in operation. The writer has been furnished recently with an interesting account of iron-making in South Carolina by Colonel John L. Black, an old-time West Point graduate and a son of one of the pioneer iron-makers of South Carolina. From it are taken the following extracts, giving some facts hitherto unpublished about the early days of iron manufacturing in North Carolina and upper South Carolina. Colonel Black says:

"Small quantities of iron were made in Catalan forges along the Piedmont slope in the Carolinas prior to and during the Revolutionary war. A Catalan forge was operated at the falls of the Reedy river on the very spot where the Camperdown cotton-mill now stands in the center of the city of Greenville, during the Revolutionary war. The limonite ores of the vicinity were used and only small quantities of iron were made. Tradition says that gun-barrels were forged on the spot from this iron. A forge was also operated at Bowen's Mill, in Pickens county, twelve miles west

of Greenville, and the writer has seen and examined the old slag at this spot, which gives indications of a very pure iron. Other Catalan forges were built and operated in Spartanburg and York counties, South Carolina, and in Lincoln county, North Carolina.

"During the Revolutionary war William Hill, the father of the late General D. H. Hill, of the Confederate army, operated a forge and a small blast-furnace on Allison creek, at the foot of Nannie's mountain, and made iron from these very pure ores. Lord Cornwallis in his advance from upper South Carolina to Charlotte, N. C., burnt Hill's works and destroyed some small iron guns Mr. Hill had cast to aid in the colonial rebellion. Vestiges of this furnace are still to be seen, and a fragment of an iron cannon, taken lately from Allison's creek, can now be seen in Yorkville, S. C.

"A small blast-furnace was erected on King's creek, seven miles southwest of Blacksburg by one Stroup, about 1822; also a Catalan forge. This furnace only blew a few weeks, when a sudden rise of the creek, flooding the fire-box, blew it out and it was abandoned. Some ten to fifteen feet of the old stack can yet be seen near McGill's mill in Cherokee township, York county. It is quite likely that some of these old Catalan forges were operated without even a power (trip) hammer and that the balled metal was hammered and drawn into bars by hand sledges. The only blast used was a rude affair known as a 'water blast' (in 1836 to 1838 I saw the remains of several of these), but blowers as cylinders were then used. In 1824 Stroup left King's creek and moved seven miles to the present site of the Cherokee cotton-factory and began to build iron-works on Broad river. This move was to get alongside of the celebrated grey ores, now the property of the Magnetic Iron and Steel Ore Company, of Blacksburg, S. C. In 1826 a company known as E. Graham & Co., composed of James A. Black, Emor Graham, Jacob M. Deal, and P. and R. Bryce, all of Columbia, S. C., and David Johnson, of Union county, bought the Stroup interest, and proceeded to build an iron-works. E. Graham & Co.'s interests were merged into an incorporated company, the King's Mountain Iron Company, with $100,000 capital, a portion of which was invested in slaves as operatives and mechanics. James A. Black was the general agent and manager of these works from 1827 to 1840, at which time he was elected to the Federal Congress.

"In 1827 the King's Mountain Iron Company erected a blast-furnace. This was replaced by a larger furnace on the same site in 1837, and this furnace was designed for a hot-blast, but only cold-

blast (charcoal) was ever applied. The present Cherokee Cotton-Mill occupies the same site. In 1827, finding they were destitute of skilled labor in two lines,—furnace founder or manager, and bloomeries,—Captain James A. Black traveled on horseback to Pittsburgh, and there after much trouble secured the services of two skilled mechanics, old and superannuated Englishmen and drunkards, out of employment on account of their intemperate habits. Purchasing another horse and wagon, he carried his Englishmen back to South Carolina and, placing under them young men from the surrounding country, soon trained his own mechanics. The services of these drunken Englishmen were not obtained so easily, as the iron-men of Pittsburgh did all they could to prevent an adventurer like Captain Black from carrying with him South the means of starting rival iron-works. Fitzhugh and Leonard, the two Englishmen, were told by parties trying to keep them from going that they would be treated as negro slaves and that they would never see another bottle of ale to drink. But Captain Black promised them a supply of beer, and to keep his promise such liquors were, with other groceries, wagoned from Charleston, S. C., a distance of 220 miles. Now and then within the last three years the writer has shipped iron ore from the old King's Mountain Iron Company's mines to Pittsburgh. In 1832 E. Graham & Co. built a rolling-mill in Union county, two miles below their furnace. In 1830 they cast guns—six- and nine-pounders—for the State of South Carolina, and quantities of round shot; also grape and canister. This was when the little Palmetto State was putting on its war paint in the days of nullification. In 1837 the King's Mountain Iron Company built a second blast-furnace on King's creek, four miles southeast of the town of Blacksburg. In the same year the Magnetic Iron Company, capital $250,000, of which 60 per cent. was invested in slaves, was incorporated, and built at Cherokee ford on Broad river, one mile above the site of the King's Mountain Iron Works and near the present town of Blacksburg, four furnaces, rolling-mill, nail-factory, etc. This company graded and operated a tramway five miles long to bring in ores, limestones, charcoal, and supplies. This was operated in 1838, and the old grade in a good state of preservation may now be seen from Cherokee ford to Gaffney City.

"About 1837 a furnace was erected by the South Carolina Manufacturing Company, near the old Cowpens battle-ground, in Spartanburg county. This company also built and operated a mill

to roll iron, and a nail-factory, at Hurricane Shoals, on Pacolet river, now the site of the Clifton cotton mills, with its 60,000 spindles and many looms. While Spartanburg is daily spoken of as the iron district, yet York and Union in the past produced ten times as much iron as the former, and all of the high-grade Bessemer ores, the magnetites, are found in York and Union. The magnetites of these counties are practically free from phosphorus and without a trace of sulphur or titanium. In 1857 or 1858 pig-iron from these pure ores was shipped to Sheffield, England, by Mr. Alexander Latham, then in charge of the Magnetic Iron Works, and converted into fine steel from which fine cutlery—knives, razors, sword-blades, etc.—was manufactured, and these articles took gold medals at the Paris Exposition of that year. Mr. Romery, of Atlanta, then a bookkeeper at these works, still has one of these razors. Captain Fred. Latham, a wealthy citizen of Charleston, S. C., a younger brother of Mr. Alexander Latham, was with him at the time and has informed me by letter of the correctness of this statement.

"In 1845 Franklin H. Elmore, then one of the stockholders of the Magnetic Iron Works and a Senator from South Carolina, had the iron from these works tested in the United States Navy Yard at Washington, where it was shown to excel all other irons, including the Swedish, in ductility and malleability, as the records will attest. During the late civil war the works spoken of above were operated to their utmost capacity, casting bolts, shot, and shell. No large guns were cast, as it was then twenty miles to the nearest railroad point, Yorkville, S. C. At the close of the war the emancipation of the slaves, and Confederate securities in which they had largely invested, bankrupted all the companies. The supply of charcoal was exhausted and the works stopped."

After the war these properties fell into the hands of creditors and the courts, and for a long time were tied up. Recently all litigation has been ended and the properties secured by one company, but no active work of development has been undertaken, though two railroads cross at Blacksburg, within two-and-a-half miles of the property. A leading English expert, after investigation, reported that one property in this section had on it, accessible to easy mining, 20,000,000 tons of magnetic ore suited for Bessemer steel-making and almost identical with the best Swedish ores.

The history of this case is but a type of many others in Virginia, the Carolinas, Georgia, and Tennessee, and for this reason it is given in such detail. The destruction of these works during the

war, the poverty that followed that disastrous struggle, the litigation with creditors, furnish some of the reasons why, for fifteen or twenty years after Appomatox, the South was not able to begin anew any active industrial development.

There was another reason which may be illustrated in the destruction of an industry in which the United States was at one time one of the foremost nations of the world. Prior to 1860 this country was a great maritime power, its mercantile marine exceeding Great Britain's; its ships were found in every trading port in the world and its shipyards gave employment to many thousands of skilled mechanics. When the war ended we were practically without a navy, without ships or shipyards. Rich as this country is, were we able to rebuild our navy, to line our shores with new shipyards, and to send the millions of bushels of grain, the petroleum, the cotton, and other exports to Europe in ships flying the American flag? The war ended twenty-seven years ago, but we are just beginning to secure a new navy and to establish new shipyards, and nearly every bushel of grain and bale of cotton which we ship to Europe goes in foreign ships. Why then should the South be condemned for its failure to rebuild promptly its furnaces and its rolling-mills, to start new cotton-factories and other industries, as soon as the war ended? While we were at war the world's shipping interests were revolutionized. Iron steamers supplanted wooden sailing ships and we were not prepared to keep up with this new order of things. When the war ended iron-making had changed. The Northern industry had been stimulated tremendously; coke-furnaces of large capacity had supplanted the small scattered charcoal-furnaces; great rolling-mills had taken the place of the little works that had formerly produced iron for local consumption. The North had captured the iron trade, as England had captured the shipping business. The South was too poor to undertake any iron development then, and every year added to the commanding power of Northern iron interests.

The early activity displayed in iron manufacture in the South was duplicated in other branches of manufacturing and in railroad construction. A study of the Census of 1860 presents many striking facts in support of this. In his report to the Secretary of the Interior written in 1862, Mr. Kennedy, Superintendent of the Census of 1860, said: "The Southern States have been behind the Northern in their public enterprises, though at the date of the Census they were prosecuting them with great energy and vigor."

Railroad-building was one way in which this activity found expression. In 1850 the New England and Middle States had 4798 miles of railroad in operation, and the Southern States had 2335 miles, or less than half as much. In 1860 the former had 9510 miles, a gain of less than 100 per cent., while the latter had 9897 miles,—300 miles more than the former, and over four times as great a mileage as in 1850. In that period of ten years the South spent more than $220,000,000 in the extension of its railroads Every Southern State shared in this activity. Virginia increased its mileage from 515 to 1771 ; the two Carolinas from 537 to 1876 ; Georgia from 643 to 1404 ; Florida from 21 to 401 ; Alabama from 132 to 743 ; Mississippi from 75 to 872 ; Louisiana from 79 to 334 ; and Kentucky from 78 to 569. In 1850 there was not a mile of railroad in Texas, Arkansas, or Tennessee; in 1860 there were 306, 38, and 1197 miles respectively in these States.

For those who imagine that the South prior to 1860 was a country of idlers here is a significant fact which needs no comment. The percentage of increase in population in the South from 1850 to 1860, even including the slaves, was 24 per cent., while in the rest of the country, due largely to the heavy foreign immigration, of which the South got none, the gain was 42 per cent. Yet in 1860 the railroad mileage in the South was 319 per cent. greater than in 1850, while in the rest of the country the increase was only 234 per cent. In round figures the South had one mile of road to every 700 white inhabitants, while the rest of the country had only one mile to every 1000 inhabitants. Counting in slaves, the proportion of mileage per capita in each section was about the same.

The South not only developed its pig-iron business, but it was rapidly increasing its diversified iron interests when the war commenced. The Census of 1860 shows that the value of steam-engines and machines manufactured in the South in that year was $6,479,000, an increase of over 300 per cent. compared with 1850, while the increase for the country at large was only 68 per cent. The manufacture of agricultural implements and general iron-foundry work also made a heavy gain. Cotton-manufacturing had commenced to attract considerable attention and nearly $12,000,000 were invested in this industry. The great majority of the manufacturing enterprises in the South were small, but in the aggregate their number and capital swelled to very respectable proportions, the total number in 1860 being 24,590, with $175,110,000 capital.

[*TO BE CONTINUED.*]

SHALL THE PROFESSIONS BE REGULATED?

By N. S. Shaler.

ALTHOUGH all times and lands have suffered grievously from quackery or the pretense of professional knowledge where the learning was not possessed, this country and our time, perhaps, have seen the most serious aspects of this evil.

Where a population is fixed, where the antecedents of men are in most cases well known, it is difficult to deceive the public by fictitious claims to professional knowledge. But a newly-settled territory, where men from all parts of the earth are gathered together and where each has to take the other, for a time at least, on his own statement as to his fitness for his calling, is naturally a quack's paradise. Having suffered much from this evil, our American people naturally are seeking ways whereby the advisers whom they select for the care of their bodies, or the custody of their property, may be proved fit for the tasks which they undertake.

Where men accustomed to the corrective influences of the law come in contact with an evil, their first idea is to mend the matter by legislation; hence it comes about that both from within and without the several professional folds there is a certain amount of clamor for State regulation, to be applied to various important occupations. The limitations applied to the practice of the law, though variable, are universal through the processes which lead to admission to the bar of the courts. Some of our States require proofs of capacity from physicians and apothecaries. It seems to many persons but a short additional step to bring all the important professions, as well as the trades which affect the well-being of the citizen, within similar limitations, so that the customer or employer may be in a way insured against falling into the hands of imperfectly trained persons. It is proposed even to put the profession of the architect in the category of occupations, the members of which must be approved by the State before they can properly become practitioners of their art.

It is true that in continental Europe the State has interfered in the regulation of employments to a degree unknown in this country. It may also be argued that this subjugation of employments to executive authority is advantageous in an immediate way.

In some instances it has served to bring about a more perfect organization of society, and the communities in which it exists are comfortable places in which to dwell; for it requires less judgment to go safely in the ways of life. But do we want to substitute State regulations for individual judgment and personal independence? It seems clear to me that it would be a mistake for us to adopt this plan of State interference, for the reason that on this line of action we risk the loss of far more than we have a chance to gain.

During the great period of governmental experiments in medieval Europe, the method of licensed trades was completely tried and, in the end, found wanting. At that time practically all the employments which demanded either learning or trained craft were close corporations,—in effect, agents of the Government to pass upon the qualifications of those who sought admission to the guild. For a time this arrangement proved advantageous. It improved the grade of the tradesman's work; it helped to organize society and develop traditions, many of which are useful even in our freer days. But all these close corporations based upon employment became, in time, controlling agents, which cramped the freedom of society and hindered its development. Among the many movements which led us out of the medieval conditions into the better air of our modern life we must give a foremost place to the motives which led men away from the thraldom of the guilds. These associations limited the migrations of population; the utmost freedom which the common man could win gave him rights in only a small bit of territory and in a narrow round of toil.

The abolition of the guild is only one of the signs of the great change which separates modern life from that of olden days and which finds its expression in the freedom of contract,—in the right of the man to dispose of his strength or skill unhampered by artificial conditions. This tendency is at the foundation of our modern democracy and is the key to the best attainments of this country. Although it is difficult to perceive the vast and wide-ranging effects which have been brought about by this element of liberty, certain of the consequences—and these of a momentous nature—may be readily apprehended. It is clear, for instance, that men profit greatly from the chance to fit their occupations to their capacities and to the conditions under which they dwell. In fact, the development of a high-grade civilization depends in great measure upon the adjustment of varied talents to the diverse work

which is demanded of the citizen. While men born into guilds, from the trammels of which there was no escape, doubtless attained a high measure of technical skill in their several crafts, they were in a way enslaved by the limitations which these corporations put upon their action.

Although the trade associations so characteristic of the later middle ages have disappeared almost entirely, there are remnants of them here and there in our societies which serve to give us some idea by living examples as to the influence of the system when it pervaded economic life. In London and other old European towns there remain substantial ghosts which represent the old trade-unions. Although these have but a trace of their ancient power, yet by their wealth and the unchangeableness of their traditions they have proved very great obstacles to the development of the modern life. It has been hard to clear away their vested interest or to turn their misused property to any legitimate objects. Now and then in peculiar occupations the methods of the guild have survived, with but little change. Thus the nailers in this country and England form a close corporation to which the admission of novices is a matter of favor, and the men of the craft have privileges which put a tax on manufacturing and insure them money benefits which should be shared by the other laborers in this field of employment. The recent difficulties at Homestead, leading to something very like civil war, have been due mainly to the efforts of a small but well-united society, composed of a special class of laborers who are endeavoring, in this modern day, to maintain the system of the guild against that freedom of contract which inevitably brings an end to such associations.

Our ordinary trade-unions, which have been so extensively developed in all branches of the mechanical and manufacturing arts, are a natural survival, in a changed form, of the ancient and more thoroughly organized guilds. So far as they have for their object the development of the individual man ; so far as they aim to promote sympathy and to uplift their members,—these associations are in the full tide of our modern life. So far as they tend to interfere with the freedom of contract and to prevent the man from doing what he pleases with his strength and his days, they are striving against that wholesome current. The same criticism applies with equal force to all those combinations of capital which have for their end any form of domination of the laboring people. The sins of these trusts are the more reprehensible and deserve the

more crushing blow for the reason that they do not represent traditional and inherited forms of action, but are new institutions which have adopted the worst form of the trade-union motive. They have no element of the larger sympathy of class which characterized the olden unions. Their sole aim is monetary gain.

In the present condition of our economic life it is evident that a struggle is going on between the modern tendencies which lead to freedom of contract and the ancient spirit which put the man for all his life in the bondage of tradition. Fifty years ago it seemed as if liberty of action, in this country at least, had been firmly established. Agriculture was the type of our life, and the farming class was so far dominant and so far free that it established for the time the principle of personal liberty. With the great development of our manufacturing industries has come this resurgence of the trade-union motive, so that except among the soil-tillers but few of our laborers dare act for themselves in determining their conduct. All the well-wishers of mankind—all those who feel a keen sympathy with the laboring classes, at least—must feel that this process of banding together the workmen of different crafts is a natural and commendable course of conduct. These workmen perceive that the incorporated capital which is their master has, in the main, but one aim, which is to get the most of their labor for the least recompense. In general they deal, not with individual men in the more or less friendly way in which a man deals with a single employer, but with a controlling agent which is essentially and almost necessarily quite mechanical in its mode of action. Nevertheless, those who have most clearly discerned the effects of the trade-union motive must doubt whether the infinitely desirable objects in the way of greater security and better pay for the workmen are so well accomplished by these agencies as they would be by perfect freedom of contract with no more unity than men commonly secure when they seek to meet a particular exigency.

For somewhat different reasons than those which determine the protective unions of hand-laborers, but with substantially the same motives, our professional classes are seeking to band their members together and to protect their occupations against the degradation which comes from the invasions made by people who are really unfitted for the employment they seek. These learned walks of life are not in any way threatened by capitalists. Their place in the community is fully established, except for the risk which may come from quackery. It seems to many of these gentlemen

that the law may fairly come to their aid to keep the public from the losses which accrue from the often captivating pretenses of uneducated impostors. So far as the practice of medicine is concerned, including in the category both physicians and apothecaries, the argument in favor of legal control seems to have sufficient popular support at present to justify a certain departure from the principle which dictates freedom of contract as the basis of relation between employer and employed, in all the walks of life. The man who is taken suddenly ill or who has met with an injury is not in a position to form judgment based on reasonable inquiry as to the professional education of the medical man from whom he seeks help. The sufferer has more than his property in jeopardy: he may pay for an error of judgment with his limb or with his life. Owing to these peculiar conditions the medical art has come to be popularly regarded somewhat as a branch of the public service, and its members are held to require some form of commission, in effect similar to that which is given to the officers of the law. An argument to the same effect could be made in favor of sanitary engineers, for they too have life and health in their keeping and may, by ignorance, inflict injuries for which no court of law can award adequate compensation.

The reasons which may be held to warrant the State in demanding proof of capacity in those who practise any part of the medical profession are not found in the other learned arts. When the services of an architect or an engineer are needed (the same is yet more the case with preachers and teachers), the clients always have leisure and opportunity, both in full measure, to ascertain the training and reputation of the person whom they think of employing. The small amount of protection which could be given by any amount of government license would, moreover, be practically of no account, as compared with that afforded by the history and repute of such professional men. Furthermore, in these occupations in which the art element is in certain cases worth more than the science, natural capacity, together with the knowledge and skill which is obtained by self-education, often count for more than all the training of the schools, though these qualities could not well be measured by any process of examination. Many of our greatest constructing engineers would have been debarred from practice on any system of criticism which could well be applied through the machinery of the law. In all those occupations where we are ever in need of the path-breaker, from the ways of the

prophets down to the lower walks of life, it is well to keep as clear as possible from the evils of examinations. It is clearly good policy to leave the proof as to the man's capacities to his actual work, allowing him to win his clientele as best he may. While the customer takes a risk when he deals with a novice, he at the same time gives an opportunity which may help in the development of genius; it is clearly a good case for a free contract and one where the presence of the law is certainly not demanded.

It is characteristic of our American spirit, or at least it has so far been an eminent feature in our life, that our law does not endeavor to protect men from errors of judgment. This is in fact one of the striking differences between our own polity and that of the over-regulated European States. Thus in continental Europe the prison awaits whoever undertakes to walk on the railway track, but in this country, it being well understood that the wayfarer takes his risk when he adopts that route, he can tramp from Boston to New York along such paths if he happens to prefer them to safer ways. He is allowed to do so on the well-founded American principle that a man knows what he is about and is the best judge of the risks which he is to incur. While there are doubtless many mischances arising from this custom of trusting the man's care to himself, it cannot be questioned that it has bred up a clear-headed, quick-witted people,—a folk eminently well endowed with those qualities of foresight and self-control which they could not well have won under the watchfulness which is bestowed upon the most of the peoples in the old world.

There appear to be sufficient means for protecting our professions against the evils which impostors inflict,—means which do not call for the interference of the State. Each learned profession can readily form a society in its own commonwealth, to which all the trained men of the particular art or science are freely admitted and from which disreputable people are excluded. It naturally will come about in time that intelligent people will learn the limits of this membership and can guide themselves accordingly. If the uneducated man succeeds in forming a clientele, although not admitted to fellowship with his brethren of the craft, it may in general be assumed that he has capacities which give his work money value. Although it is desirable to keep the quack from sailing under false colors, it is equally important to preserve the initiative motive which may lead a man conscious of his powers to essay any employment, however imperfect his training for it may have been. Even

in medicine, a profession which more than any other demands careful preliminary training, valuable contributions have come from men absolutely without schooling. Thus Presnitz, the founder of modern hydropathy, was an illiterate peasant, yet he invented methods of treatment which have been found most valuable and which, to a great extent, have been adopted by the medical profession.

The foregoing considerations seem to lead to the conclusion that any efforts to support our learned professions (except medicine) by a system of government licenses will go against the spirit of our society. So far as it is effective, it will tend to overthrow the freedom of contract which is the basis of much that is best in our modern life. Even should it be a temporary advantage to the occupations which seek this protection, it may be doubted whether they would, in the end, find their position any the stronger for the change. They now rest upon the respect which our people have for education and for deeds well done. They would surely gain nothing in dignity or station from any support which the law could give them.

BRIDGE-BUILDING IN AMERICA.

By T. Kennard Thomson, C. E.

BRIDGE-BUILDING has become one of the exact sciences only within the last twenty or thirty years. The earlier bridges—wooden of course—were built largely by "judgment." First, every stick from one end to the other was made of the same-sized timber, and when one member of a bridge failed that part was replaced by a bigger piece, and so on until every part had been made sufficiently strong. Squire Whipple, who was the first to analyze the strains in bridges, published the results in 1847, but his work did not become generally known or adopted until a much later date.

Many of our earlier bridge engineers, from Timothy Palmer, Theodore Burr, Louis Wernwag, and others, down to the era of iron bridges, showed their genius in the structures they left behind them, some of which have stood the demands of traffic for more than a hundred years. It should be remembered that it is customary now to consider the life of a wooden bridge as only from seven to ten years. One reason the earlier bridges lasted so much longer was the care with which the timber was selected and seasoned before use. Wernwag had all his timber sawed through the heart to detect unsound wood, and never used timber thicker than six inches. The bridges were first wooden trestles, then trusses and arches and combinations of the latter two. Wood and iron bridges in time became very popular, especially in the form of the Howe truss. The Pratt truss never came into general use as a combination bridge, but it is now the most common form of iron bridge. Cast-iron bridges, fortunately, never obtained the same footing here as in England, but there are still a good many to be seen.

When iron bridges came into use, the "cut and try" method of designing was of course too expensive, and engineers began to calculate the exact strains in every portion of a bridge. Such men as Squire Whipple, J. H. Linville, George E. Gray, Albert Fink, Bolman, and others had uphill work, making their own original designs without any literature or precedent to furnish suggestions. Now any school-boy can find the subject written up within his comprehension, without having to surmount any of the difficulties

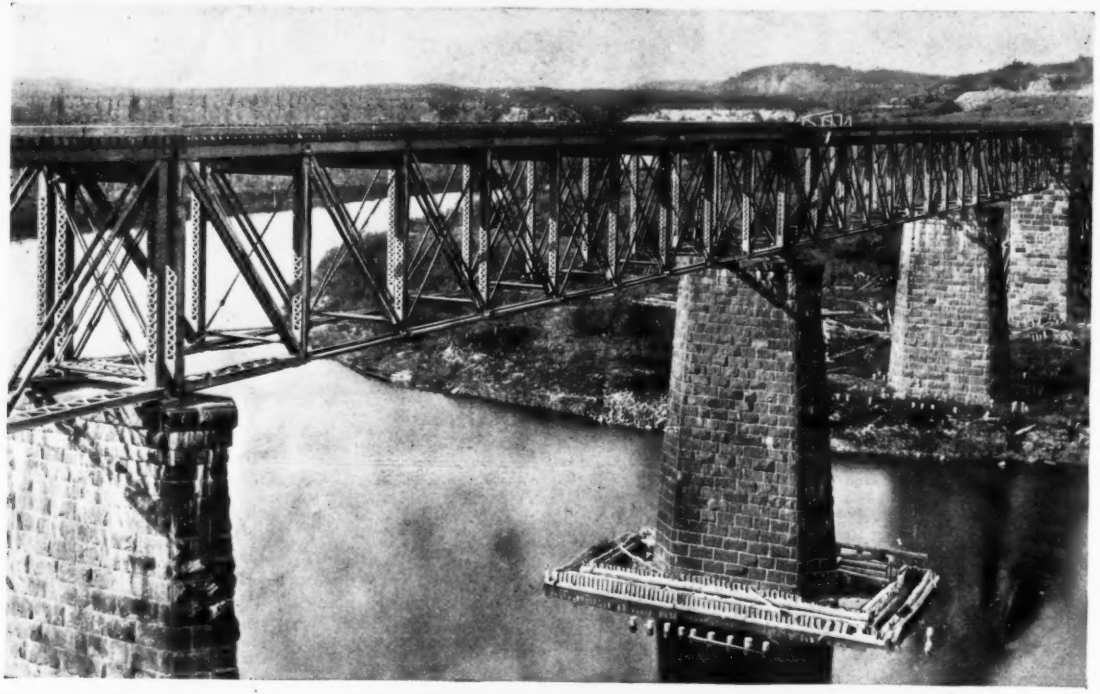
A PRIMITIVE BRIDGE, INDIAN RIVER, ALASKA.

experienced by our pioneer bridge-builders. A few years ago a casual glance at a bridge was sufficient to tell the name of the designer and builder. The designs have been gradually improved, however, until no one man can claim the credit for our best designs, the form and style depending more on the requirements than on the taste of the engineer.

In England they go to one extreme, a safe one, as illustrated by what a venerable Englishman said to a member of the American

A FOOTWAY SUSPENSION BRIDGE.

Society of Civil Engineers at an entertainment given to that body in London in 1889. He said that, when a student of Smeaton, the old gentleman came into the office one day and, finding him at work on a plan of a bridge, said: "Young man, when you make a bridge, make it strong; make it strong, sir, and when you have got it strong, make it damned strong!" Our host continued that he had followed this advice all his life. But in this country, while keen competition has greatly improved our designs, on the other hand



BIG PIC BRIDGE, CANADA—PIN-CONNECTED "PRATT" TRUSS.

the pernicious habit of letting lump-sum contracts has resulted in making the bridges lighter and lighter, skinning the details and using forms of bridges that are not well adapted for moving loads, although conforming to the specifications. The latter, by the way, seldom recognize any difference in the strains from a train going five miles an hour and one going sixty miles an hour. Sooner or later these rattle-traps will be discarded, as they have been already by some of our more advanced railroads, and it will be realized how slight is the difference between the cost of a good bridge and of a poor one. It is a great pity that this change is kept back by the

DECK BRIDGE, PLATE GIRDER, AT LODI, N. Y.
[Lehigh Valley Railroad, 1891. Length of Span, 105 Feet.]

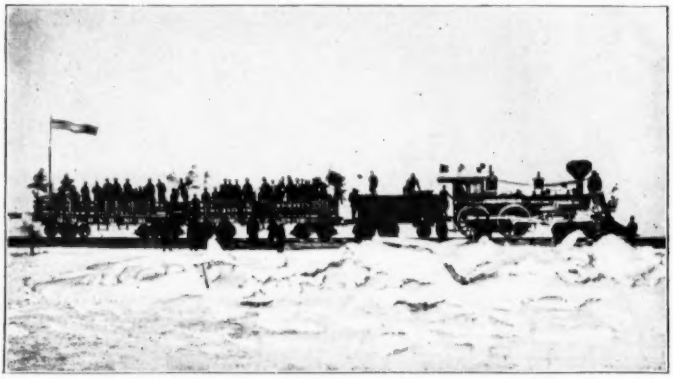
representatives of some of our oldest bridge-building companies, who will swear to almost anything to gain a small contract.

In this country to-day the best practice in bridge-building is to use eye beams for spans up to 18 feet; plate girders for spans 18 to 80 or even 100 feet; lattice or open-riveted girders from the last limit to 120 feet; pin-connected trusses to 550 feet; cantilevers from this limit to a span somewhere between 1000 and 1500 feet; after which economy requires suspension bridges. Continuous girders, or bridges connected or made continuous over two or more spans, have gone out of favor, owing to the ambiguity of strains, the least settlement of a pier rendering the strains uncertain. Of course where these bridges are built they are provided

OLD SUSPENSION BRIDGE, ST. JOHN, NEW BRUNSWICK.

with adjustable shoes, so that if the piers settle the bridge can be raised, but this requires great watchfulness. The above limits are necessarily subject to change, owing to local circumstances, such as the difficulties of erection, etc. For instance, in the Lachine bridge, where the St. Lawrence river made false work out of the question, the two channel-spans of 408 feet each, were built as cantilevers, but turned into continuous girders when coupled up or completed.

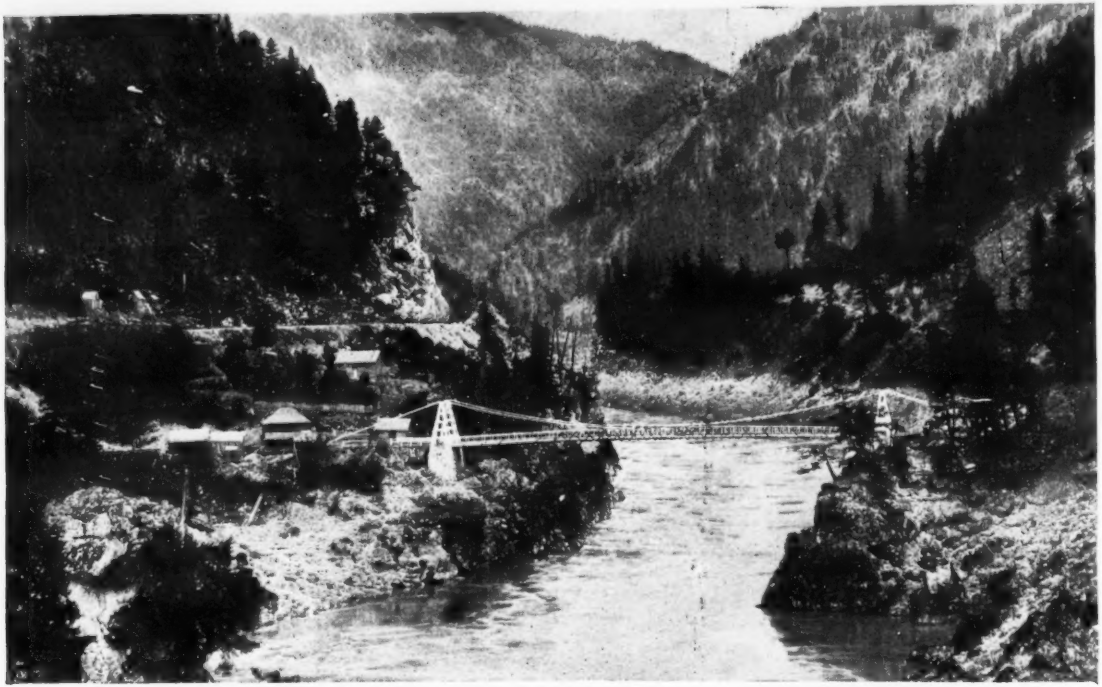
Although the principle of the cantilever has been known for ages, it has only recently been adopted for long-span bridges; first by the late C. Shaler Smith of St. Louis, and by Mr. C. C. Schneider, chief engineer of the large bridge companies. The latter designed



AN ICE BRIDGE OVER ST. LAWRENCE RIVER, NEAR MONTREAL.
[Wooden Stringers Laid Directly on the Ice.]

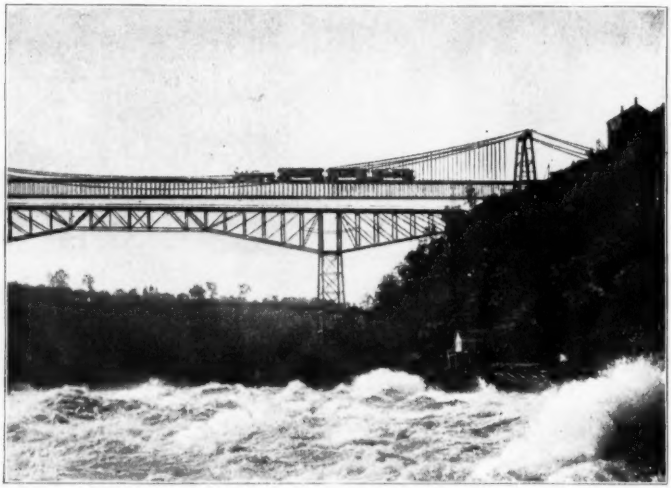
the Niagara and Fraser river cantilevers. One of the earliest iron bridges built in England was the tubular,—a box tunnel made of wrought-iron plates and angles,—the first of this type being the bridge over the Menai straits in Wales. The only important one built on this continent is the Victoria bridge at Montreal. In recent years a greater part of the top of the Victoria bridge and a considerable portion of the sides have been removed. This permits the smoke from trains to escape and really strengthens the bridge, as it has removed a considerable amount of dead weight. While tubular bridges are not now built, they certainly were wonderful in their day for ingenuity and boldness.

The greatest cantilever ever constructed is the Forth bridge, with 1700 feet clear span, while our East-river suspension bridge



CARIBOO ROAD BRIDGE—A HIGHWAY SUSPENSION BRIDGE IN THE ROCKY MOUNTAINS.

is the next greatest bridge. The bridge designed by Mr. Lindenthal, a sixteen-track suspension having a clear span of 2800 feet, over the North river, will throw these into the shade. Work on this gigantic structure probably will be begun soon. The writer has made plans and estimates for a six-track cantilever over the East river, with spans of 1100 feet. While we cannot but admire the Forth bridge, it is not likely that it will ever be reproduced in this country, though any one who attempts to design an equally strong cantilever of the same span and strength with less material will find his respect for the Forth much increased. By using rectang-

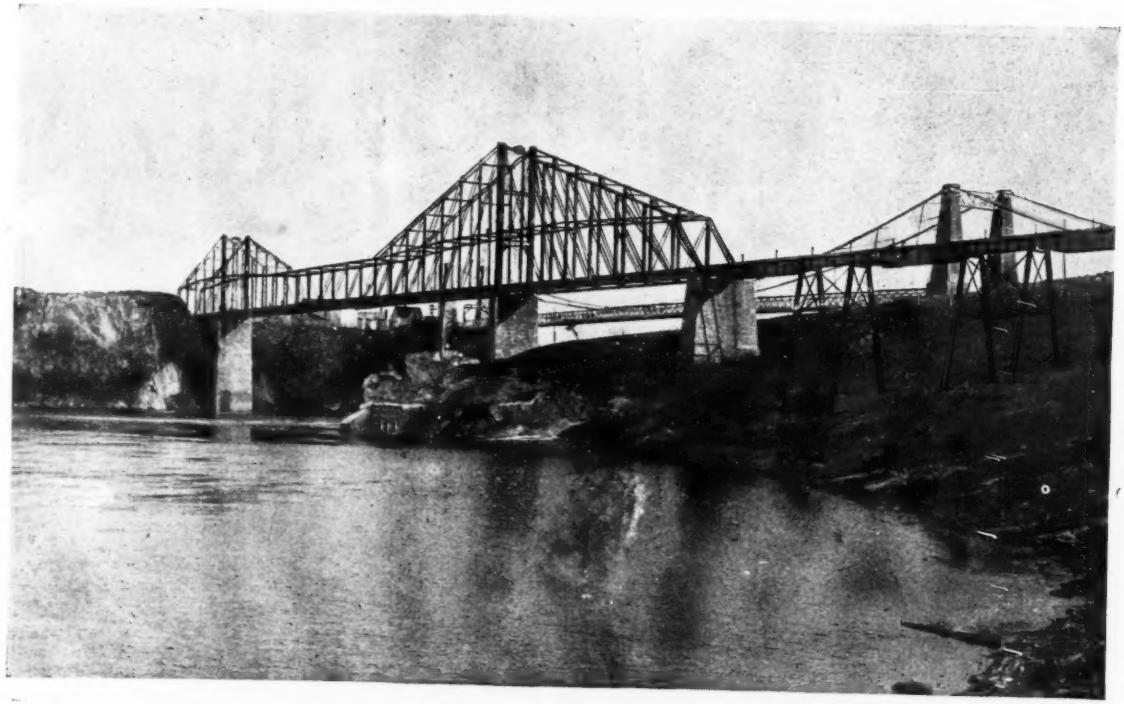


NIAGARA CANTILEVER, C. C. SCHNEIDER, 1883.
[Niagara Suspension Bridge with New Steel Towers.]

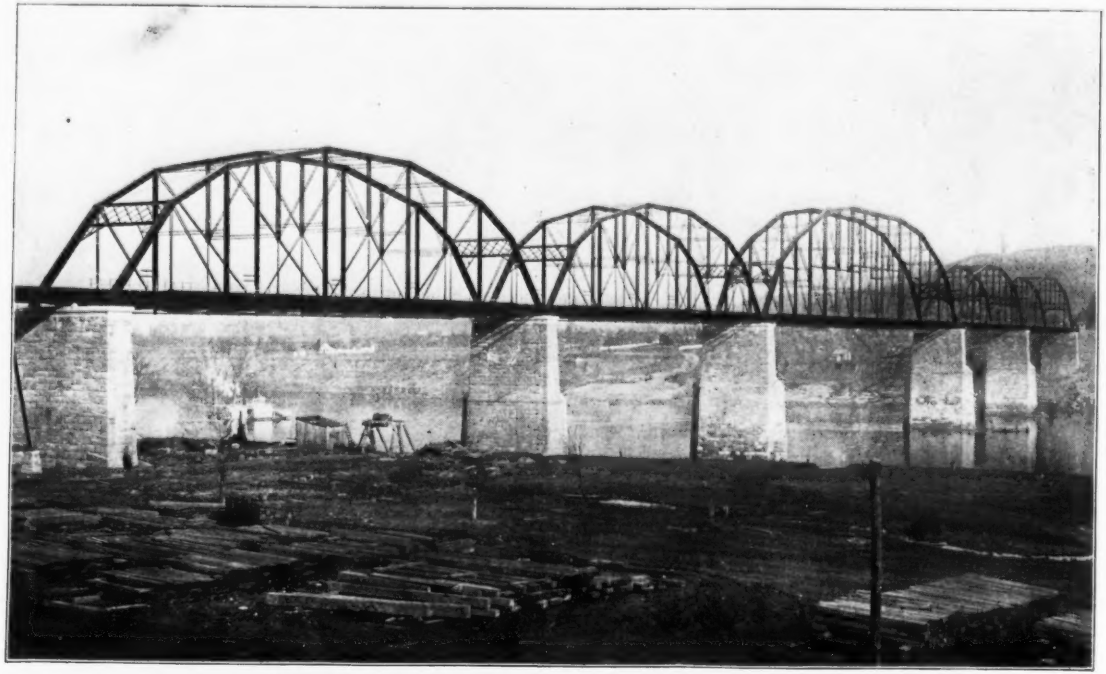
ular sections instead of circular, and pin connections instead of rivets, we could erect a bridge in very much less time.

The old suspension bridge at Niagara was built by John A. Roebling, of Brooklyn-bridge fame. This was built originally with stone towers, iron cables, and wooden trusses. Some years ago it was discovered that the cables were being eaten through and that the towers were in bad shape. Mr. Buche of New York then accomplished the feat of replacing the old cables with new ones, erecting steel towers in place of the masonry and replacing the wooden trusses with iron, and all this without interrupting the railway traffic. The suspension is undoubtedly the most graceful

FRASER RIVER CANTILEVER, CANADIAN PACIFIC RAILWAY—C. C. SCHNEIDER, 1885.



CANTILEVER BRIDGE AT ST. JOHN, N. B., 1885.



KENOVA BRIDGE, NORFOLK AND WESTERN RAILROAD, 1891.

Three Spans of 304 Feet.
One Span of 520 Feet.

Bottom of Bridge 100 Feet Above Low Water.
Bottom of Bridge 40 Feet Above High Water.

BROOKLYN SUSPENSION BRIDGE, EAST RIVER.
[One Span of 1595 Feet; Two Spans of 930 Feet.]

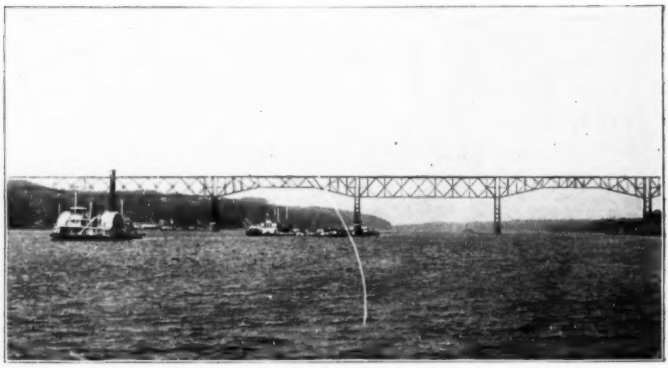
WASHINGTON BRIDGE, HARLEM RIVER, NEW YORK.
[Two Spans of 510 Feet.]

long-span bridge, but it is not as rigid as the cantilever and, as usually designed, has more or less ambiguity of strains. The Norfolk and Western railway bridge over the Ohio river at Kenova, W. Va., is a novelty in that the bottom chord is made up of two sets of eye-bars, seven feet apart, vertically. This design makes the floor system very rigid and improves the connections.

Considering the ignorance on the part of many bright architects

NEW YORK ELEVATED RAILWAY.

and railroad engineers of the simplest principles of bridge-designing, it is really wonderful that there are no more failures. To take only two cases: A young architect who has just won the first prize for the design of a 250-feet roof made the surprising statement that he knew nothing of strains, and that, while he would like to make a study of the subject, he was "obliged to take up the more important branches first." The other case is that of a chief engineer



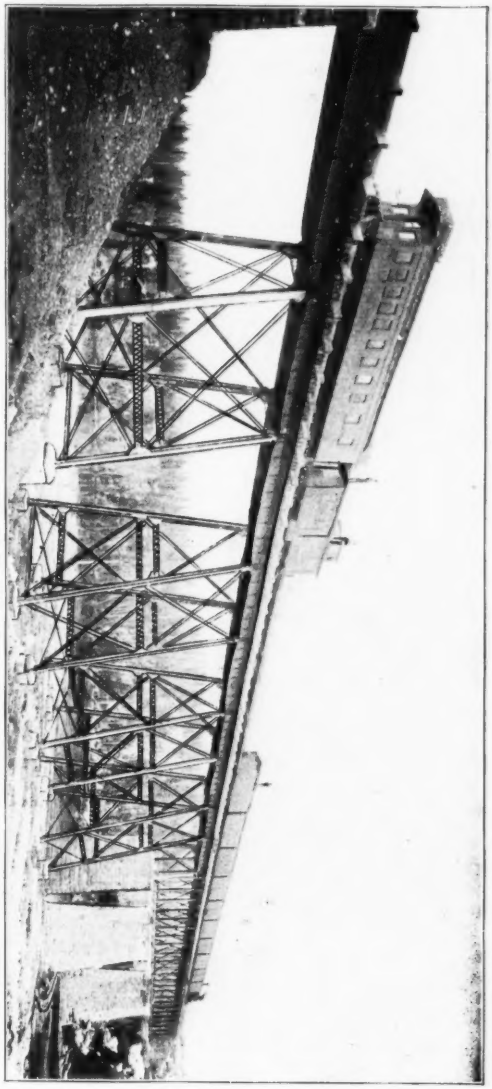
POUGHKEEPSIE CANTILEVER, HUDSON RIVER.
[Three Spans of 546 Feet; Two Spans of 525 Feet.]

who tried to design a through bridge by turning a deck bridge upside down.

To show that the strains are the same whether applied at the top or bottom of the bridge, suppose we have a timber beam resting on two supports and then apply a very heavy load either to the top or bottom of the beam. Either position of the load will cause the beam to deflect, and this deflection will necessarily shorten the top of the beam (that is, compress it) and lengthen the bottom. We have

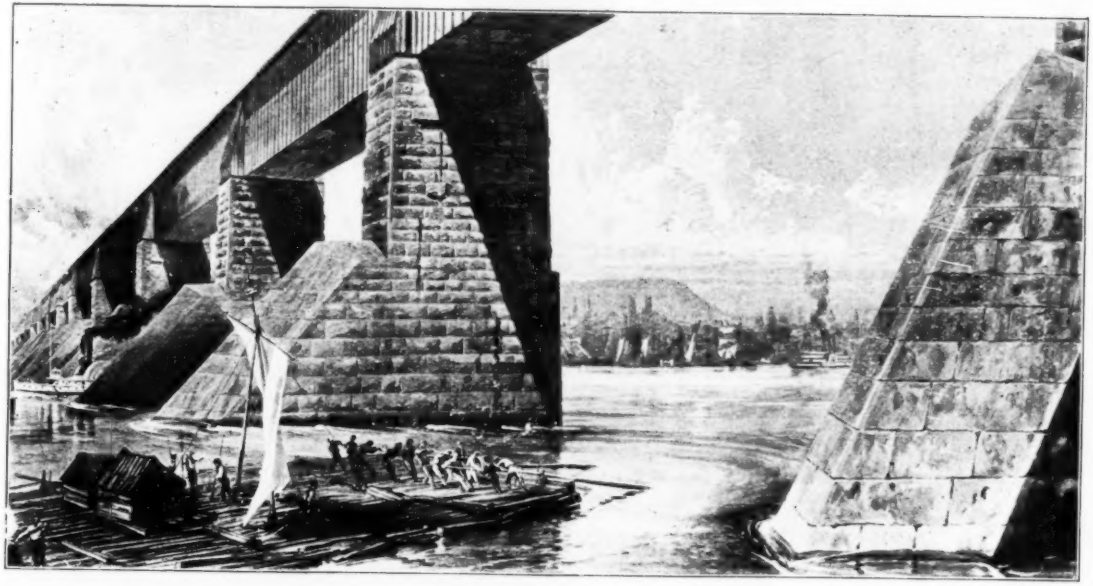
MENAI (WALES) TUBULAR BRIDGE—STEPHENSON, 1846–1850.
[Two Spans of 460 Feet; Two Spans of 230 Feet. Cost $3,000,000.]

then compression in the top of the beam and tension in the bottom. This applies to all bridges resting equally on two supports. The knowledge of this simple fact would have saved a number of disasters. The writer once saw a letter from an excellent engineer who, however, attempted to build a bridge without the theory and then reported that "the bridge at this creek was swung at 2 o'clock and then failed." His error lay in putting his compression joint in the bottom chord, where, as we have seen, he required a tension joint.



A PLATE GIRDER VIADUCT.

Many of our capable railroad chief engi-



VICTORIA TUBULAR BRIDGE OVER THE ST. LAWRENCE RIVER AT MONTREAL.

[Twenty-four Spans—One of 330 Feet, the Rest from 242 to 247 Feet. Cost $7,000,000. Robert Stephenson, 1854 to 1859.]

neers prefer to let the bridge companies design their own bridges, but no one is really competent to check a design unless he can first make one. An ideal training for a graduate of a technical school would be to spend a year or so in the draughting-room of a bridge company, go into the shop for a few months, and also out on the erection of bridges. If he should then spend some time in the designing office of both a bridge company and a railroad, he ought to be able to design a good bridge. If he has omitted any of these steps, he will always have, or give, more or less trouble. The engineer of a railroad and the engineer of a bridge company have often two distinct objects in view, the first being governed by local conditions of streams, grades, etc., and the latter by economy of shop-practice. The man who has served in both capacities can design the best bridge for the least money. A fallacy far too common is the supposition that anybody can enforce the specification for a bridge. The necessary specifications for an expert could be put on one sheet of paper, but then could not be made long enough for an inexperienced man.

Our specifications, like our bridges, have come to be the work of many men. They have been added to to such an extent that they are now almost as absurdly verbose, lengthy, and vexatious as a lawyer's document. One source of annoyance is the engine diagrams, for nearly every railroad adopts a different diagram—and sometimes two or three—giving the spaces between the wheels as so many feet, inches, and sixteenths of an inch. It of course involves a great deal more labor to calculate the strains from these diagrams than if the wheels were considered as so many even feet apart. It is claimed by some that by using the graphical methods this difficulty vanishes, but these methods are not always convenient; for example, the writer has often been called upon to calculate the strains in a bridge when he had nothing but a pencil and scribbling-pad to help him. In many cases these "typical engines" are never even built, and even where they are they do not represent *all* of the engines run over the bridge, by any means.

The slightest difference in the diagrams requires fresh calculations, and there are dozens of diagrams which are liable to change at any moment; consequently it is almost impossible for an engineer to tabulate his strains to save calculating them over for every bridge. Many calculators go on using these diagrams without complaining, saying that they would rather be as exact as possible. One is reminded of the military gentleman who paced the circum-

ference of a circle and then calculated the radius to six places of decimals. It is a great pity that the American Society of Civil Engineers does not recommend the adoption of two or three standard diagrams, so that any chief engineer could select the one best suited to his road, which he would gladly do. The necessary tables for these diagrams could then be published, and much of the drudgery of calculating be done away with.

Another matter that this society might take up with advantage is that of unit strains; that is, how much load per square inch of metal each member of the bridge should carry. A great many specifications have absurd formulæ,—absurd because they are founded on assumption instead of facts, and because the results could be stated quite as accurately at once instead of putting one to the trouble of solving the formulæ. What is the use of specifying that iron shall break between 46,000 and 52,000 pounds per square inch, allowing a variation in weight or shape of the finished iron of $2\frac{1}{2}$ per cent., and then giving a formula which will require a working strain of 8121 or 7903 pounds per square inch, instead of stating 8000 pounds at once? Many claim that this is not scientific, or does not allow for impact or shocks from rapid strains. But instead of increasing the sections where the impact is greatest, most of these formulæ decrease it where it is less. Besides, we could easily write out tables to allow for impact just as accurately as these formulæ do. What is really needed is an elaborate system of experiments on all sizes and shapes of bridge members, which should be tested to destruction, and also on every part of existing bridges by means of some instrument like that invented by a Frenchman, to be fastened to the member and indicate the strains. Formulæ founded on such facts would be worth using.

One result of the keen competition among bridge companies has been to cut down the thickness of plates and angles. One or two of our railroads, like the New York Central, will have no iron less than $\frac{3}{8}$ of an inch thick. The writer's own experience, in both shop and field, leads him to object most emphatically to the use of iron of less thickness. Yet iron is coming into use as thin as $\frac{5}{16}$ and even $\frac{1}{4}$ of an inch. Contracts for iron and steel bridges should be let by the pound, and a competent bridge engineer employed, but if the contract is let for a stated amount (lump-sum), each bidder—perhaps half a dozen or more—will have to go to the expense of making careful plans and estimates. As only one company can get the contract the work of the rest is wasted. The railroads pay for

this waste indirectly. Bridge companies *as a rule* do not lose money. If they bid less than a good job is worth, they will not give a good job. The writer knows of a case where an engineer's inspector calculated the weights of some twenty bridges on a "pound" job. These calculations were made from the drawings, before the shop-work had been commenced, and aggregated 2,514,481 pounds. As each shipment was made the bridge builders forwarded the exact scale or shipping weights in detail, which added up to 2,513,250, or 1231 pounds less than the calculated weights. Of course some of the details differed more, but never more than the allowable $2\frac{1}{2}$ per cent.

Shop-work in this country is generally very exact. The different members of a bridge, for example, are seldom assembled until they are placed in their final position in the field, and very few mistakes are made. The English, on the other hand, fit everything together in the shop. There was recently erected in that country a big cantilever intended for India, on false work, using miles of timber. We have too much confidence in our work and designs to waste so much time and material in this country.

In the reduction of iron ores to merchantable iron the latter takes up more or less of the carbon and other substances used in the process, which remain in the metal as impurities of which the engineer must take cognizance. Of the forms in which iron is generally used, cast iron contains the largest amount of carbon, and it is not now used in bridges except in places where strength is not required. Wrought iron contains the least carbon, and may be almost pure. Steel lies between cast iron and wrought iron in its proportion of carbon. The more carbon the steel contains the greater its tensile strength and the greater its hardness and brittleness. Therefore a mild steel is to be preferred,—one low in carbon,—for while it will not stand as great a direct pull, it is tougher, can be bent double, and will not snap.

It is not necessary, however, for the bridge engineer to specify the amount of carbon. If he gets a steel which will break between 50,000 and 65,000 pounds per square inch, always regain its original shape up to 35,000 pounds, stretch about 22 per cent. of its length before breaking, bend double on itself, and show a good silky fracture with no crystalline appearance when broken, he need not bother his head about the carbon, as it will be low. The only chemical test he requires, therefore, is for phosphorus, which should never exceed $\frac{4}{5}$ per cent. Sulphur is nearly as treacherous,

but it is eliminated at the same time as the phosphorus. Some engineers call for steel for compression members in bridge-work to stand 70,000 or 80,000 pounds per square inch, but this grade is not nearly so reliable as mild steel. The writer expects to see mild steel supplant wrought iron entirely for structural purposes.

Some of the railroads have their iron inspectors at the rolling-mills and bridge-shops, while others let a contract generally for about seventy-five cents a ton to an inspection bureau. Some of these bureaus are run by very able men, who have experienced local managers in different cities, but unfortunately they often employ inexperienced boys at from $40 to $50 a month to do the inspection. If the boy does not satisfy the contractor, the local manager is appealed to, and the matter is often adjusted, but the railroad is liable to suffer from the ignorance without any one being on hand to find fault. One thing in particular that all inspectors at rolling-mills should be instructed to do is to stamp the piece that is to be cut off of a plate or shape for a test piece. As it is now, very often the inspector goes into the testing-room and the man in charge for the rolling-mills hands him a piece of iron or steel, saying that it is a test piece, but the inspector has no means of telling whether it is cut from his material or not. In fact, some mills are said to keep a pile of test pieces of a known grade in stock.

The inspection of a bridge from the first drawing to the last coat of paint cannot be too thorough. Many think it unnecessary to inspect the erection, but this is very important. I was once instructed to inspect the erection of a long bridge of which the first span of the approach had already been completed. The field riveting had been so badly done that the superintendent of construction was instructed to go over the work himself, and was kept going over it until he had marked and cut out about 400 bad rivets. The riveting on the work thereafter was really well done; the bad work had cost too much.

The writer does not wish anything in this article to be considered as a slur on either the proprietors or managers of the bridge companies, with the work of most of which he is familiar. He has found over and over again, where their men were honest and desired only to turn out good work, that they could not always watch all of their employés, who often seem to prefer doing bad to good work, even where it is cheaper and easier to do good work. One is apt to have the same experience with masonry contractors. It can be imagined, then, how much worse it is when

the company encourages dishonest work and makes things so disagreeable that no first-class inspector can remain long in their shops.

The railroad commissioners of the State of New York have done good service by condemning many unsafe bridges and requiring the railroads to have the strains calculated on all their bridges. Every State should have a similar commission for both railroad and highway bridges. As most railroads have some sort of inspection, however poor, and most highway bridges have none, the latter are, as a rule, much more dangerous than the former.

INDUSTRIAL DECADENCE IN GERMANY.

By James C. Bayles, Ph. D., M. E.

RECENT observations in Germany, under conditions which brought me into more or less intimate contact with manufacturers, have led me to the conclusion that the danger of industrial paralysis is much more serious and more imminent than that due the alliance supposed to exist between France and Russia for her ultimate overthrow and humiliation. How great the latter danger may be I have no means of knowing, but one does not need to be long in the country to discover that the former is approaching rapidly and inevitably.

Circumstances which diplomacy cannot at present alter, and which are likely to continue operative for many years to come, compel Germany to maintain a military establishment out of all proportion to its population and natural resources. It has been the battle-ground of Europe for centuries, and from its geographical position must take the brunt of any war which may result from the unceasing friction of the great powers. William II. came to the throne fully imbued with the spirit of his warrior ancestry, and is popularly regarded as a "military crank," who believes that he has inherited the genius of Frederick the Great. But however pacific his disposition or conservative his policy, he could not for a moment disregard the fact that not only the existence of the empire created by his venerable grandfather, but the security of his throne as King of Prussia, demands that the German military establishment shall be as extensive and perfect as possible, and that all other considerations shall be subordinated to the maintenance of an army sufficiently formidable to hold in check the forces tending to remodel the map of Europe. However disastrous, as affecting the economic interests and industrial development of Germany, these gigantic war preparations may be, they are presently necessary. Public opinion demands and approves them, and to expose Germany to easy invasion or even to the loss of her newly-recovered Rhine provinces would invite revolution. Even those who feel most keenly and deplore most loudly the burdens entailed by the system of national defense admit that it is a necessity, and applaud the policy which seeks to make Germany the greatest mili-

tary power of the world. Of two evils the German people unhesitatingly choose the lesser. The instinct of national self-preservation is always stronger than the desire for immediate material welfare. The Germans are a very practical people. It is probable that among the increasing minority of Social Democrats there are many who dream of Utopia, and long for the time when the universal brotherhood of mankind shall be so firmly established in liberty, equality, and fraternity that even national boundaries shall be forgotten in a grand federation of communal republics. But even these amiable prophets of a millennium of peace and good will are loyal and patriotic, and recognize that Germany's present necessities are exigent. No doubt they would be among the first to move for the overthrow of a government which should neglect any part of its duty of keeping Germany defensively impregnable and offensively formidable. They may regard universal disarmament as the end and aim of statesmanship, but would resent with great and unnecessary emphasis the suggestion that Germany should set the example to the powers.

Meanwhile the fact must be recognized that to maintain her present military establishment is straining the resources of Germany to the breaking point, and that of the many resulting evils heavy taxation is probably the least. "Ill fares the land, to hastening ills a prey," where the soldier is honored and the mechanic despised. Incidentally this is the condition of Germany to-day,—incidentally, not because the popular sentiment, if formulated in words, would find this expression, but because it is the outgrowth of a national policy which is firmly established in popular approval. Every German of average physical and mental development, not a convict, is a soldier between the ages of seventeen and forty-five. During this period of twenty-eight years he is not, of course, continuously in active service, but he is through it all a soldier, and his chances of becoming a good mechanic are small. At seventeen his liability to active service in the ranks begins, and between that age and twenty-one he must give three consecutive years to military duty as an enlisted man. Every boy not so fortunate as to secure admission to a military school whose graduates are commissioned, and who thus makes the army his profession, looks forward to enlistment under conscription or as a volunteer as the first important event of his life, and shapes his plans in accordance with it. Unless imbued with the military spirit and desirous of wearing a uniform, he will, if possible, leave the country

before he is called upon to serve. Very many do this. It means expatriation, since the young man who thus escapes the obligations of citizenship cannot at any subsequent time avail himself of its privileges and benefits. This emigration depletes to a serious extent the national vitality.

If, on the other hand, the young man has good abilities and advantages and can command an education, he has every incentive to qualify for a professional career. By attaining a standard of scholarship which will enable him to pass an examination entitling him to enter a university, he may return to his studies after one year of service in the ranks. The only other class enjoying this privilege of brief service are the graduates of normal schools who wish to pursue the teacher's calling. From neither of the classes named would the manufacturing industries be likely to draw apprentices. The average young man, who would naturally pass the period from his sixteenth to his twenty-first year in the workshop, is apprenticed to the trade of war instead. For the three years during which his character and tastes are forming and when he is most susceptible to the influences of his environment he becomes a soldier. After three years he enters for five years the reserve, during which time he is almost as much a soldier as during his first period of enlistment. In the next five years he belongs to the first levy of the Landwehr, and then, until he is forty-five, to the Landsturm. He may then settle down to the serious concerns of life, reasonably secure against further interruption unless war should necessitate an extraordinary conscription ; but long before he is forty-five—in fact, during his first three years of service—he is more or less completely unfitted for the commonplace industry of the workshop.

As the rule, young men who cannot emigrate and who lack the opportunity or incentive to become students are anxious to enter the army as soon as they can. It emancipates them from the restraints of parental control, and changes them from boys to men at a step. Most of the recruits are enlisted between the ages of eighteen and twenty, and in appearance and manner give every indication of mental and physical immaturity. Thorough drill, strict discipline, wholesome food, and good medical supervision combine to induce a rapid and satisfactory physical development and to make good soldiers out of what would appear to be rather inferior material ; but the influence upon the habits, tastes, and ambitions of these young men, of three years of barracks life, is well calcu-

lated to unfit them for manual industry. As a soldier, the young conscript soon learns to consider himself superior to the citizen; and he regards with ill-concealed contempt the mechanic and artisan. His uniform secures him certain privileges and immunities, which he jealously guards against encroachment. Lacking experience of the practical concerns of life, he cannot look at any question from the point of view of the tax-paying citizen. He may at any time be called upon to aid in suppressing riot or rebellion, and thus learns to regard as public enemies the very class to which he properly belongs and to which he must return.

Two incidents which occurred lately in Berlin are instructive as showing the contempt of the soldier for the workingman. One of these was the shooting by a sentry of a citizen who said something sarcastic or impertinent. The sentry had no other apparent provocation for his murderous act than that his victim ran when called upon to submit to arrest. It pleased the Emperor to specially honor the soldier, with what influence upon the army at large may be imagined. The other incident was the brutal attack by a sergeant upon some workmen who crossed the street between the battalions of the relief guard. Two of these unfortunates were clubbed into insensibility and left lying in the street by the troops which marched over them. They had broken a military rule, but not a law imposing any obligations upon citizens.

Incidents of this sort are of frequent occurrence. Encouraged by the example of their officers, who are not as the rule at all considerate of civilians, and who often display an insolence which would not elsewhere be tolerated, the soldier soon gets an exaggerated idea of himself. To exchange his uniform and helmet for the blouse and cap of the workman is to the average soldier extremely distasteful. If he does so, it is because the only alternative is starvation. His normal ambition is to find employment in some branch of the uniformed civil service,—the police; the railways; the postal or express departments; as porters,—anything, in fact, which commands a government salary and by its uniform raises the incumbent to a dignity above that of the civilian. It was difficult for me to appreciate how far this idea is carried, until one Sunday when I mistook a post-office clerk in gala dress, with gold lace, brass buttons, and sword, for a general officer.

If the soldier, when discharged, has any political or social influence, he uses it to secure a civil appointment, and not until he finds the quest hopeless is he willing to give it up. Those who

come from the farming districts and return to homes and associations remote from garrisons and practically outside the circle of military influence are more easily and naturally absorbed into their accustomed occupations; but the young men from cities and towns, who might, and probably would, have become skilled workmen and mechanics from choice, enter such employments unwillingly and are all their lives handicapped by the pernicious influence of military tastes and associations.

As the result of careful inquiries, verified as fully as possible, I should consider the following generalization not unsafe. Out of an average one hundred town-bred young men who are eligible for military duty, ten will strive for and five attain the standard of scholarship which entitles them to the privilege of brief service as students. Most of these subsequently emigrate in search of better opportunities for professional work than are found at home. Of the 95 conscripted for three years, probably 80 are mustered in for that period, of whom say 25 are relieved at the end of two years for superior proficiency and exemplary conduct, but may at any time be called back to complete their term of enlistment. Few of this class would, in any case, have become mechanics, and when discharged they seek employment as clerks or book-keepers. Of the remaining 70 who serve three years, probably one-half are intelligent enough to see that they are losing valuable time, and will make their plans to engage, when discharged, in some occupation in which success is not dependent upon thoroughness of training. If they cannot secure civil appointments and have no inducement to emigrate, they may reluctantly enter the workshops; but this is always a last recourse. A good many become students. Probably not 20 in the hundred elect to become skilled mechanics. That their success is limited is not surprising. Their thoughts are in the barracks, and they long to return to the associations of army life. They are not at home in the workshop, and it is long before they become so. At best they are restless, discontented, unsettled, ready to rejoice at the proclamation of war. As they grow older no doubt this feeling gives place to a more reasonable conception of the responsibilities of life. If they marry, as they are very likely to do, the increasing pressure of social and domestic responsibility is calculated to make them very practical, but until, at forty-five, they are finally discharged, the fact that they are German soldiers dominates all other ideas.

Considering the facts which have been outlined, it is not sur-

prising that employers of labor in trades demanding skill and experience find increasing difficulty in filling their shops with men able and willing to become master mechanics. The lack of skilled labor and the scarcity of material from which skilled workmen can be made is already a serious discouragement to the establishment of new industries in Germany, as well as to the maintenance and extension of old ones. So long as the first duty of the citizen is to his king, and the twenty-eight best years of his life are interrupted by the more or less constant demands of military duty, the tendency must be towards national impoverishment and industrial paralysis.

In many German workshops I was struck with the fact that the working force consisted chiefly of young men of inferior physical development—undersized, hollow-chested, unhealthy-looking lads —and old men wearing as spectacles strong round lenses mounted in heavy brass frames. There was a noticeable dearth of men from twenty-five to forty, who, in our American workshops, represent the highest skill and capacity. The young men were listless, tired-looking fellows, evidently dissatisfied with life, and with little or no ambition. The old men were slow, deliberate, and, in a degree, clumsy. The average output of work in a German shop, per unit of labor, is probably not more than half of what it is in this country. I mingled freely among the idle workmen who crowded the Lustgarten on the occasion of the demonstrations last winter of which such exaggerated accounts were sent to the newspapers. They had been largely thrown out of employment by disturbances in international trade relations due to the present American tariff, and so sensitive has German industry become to causes which elsewhere would be scarcely noticed that they saw no hope of re-employment. In this great multitude, numbering probably twenty thousand at times, there was a surprisingly small percentage of men who looked at all like mechanics. Those who marched with the relief guard and so tried to break through the police cordon surrounding the Palace were distinctly boys,—nearly all undersized; those who in the Lustgarten quietly waited for them were mostly men past middle life,—pathetic old veterans, whose sad eyes looked strangely when seen through their spectacles. The only men in the multitude from whom anything was to be feared was the little sprinkling of Anarchists and Social Democrats—mostly political refugees from other countries—who were stranded in Germany and would gladly have organized serious riots had there been any inflammable material among the German workmen.

In intercourse with manufacturers I learned, better than I could have done from the workmen, the trouble experienced by employers of labor from the causes noted. The impossibility of getting together and holding a capable force of workmen was never so great as now. Between the attractions of emigration and the opportunities for education, only those remain available for the workshops who cannot get away and have no capacity or desire for intellectual improvement. Out of this class it would be possible by judicious selection to maintain an adequate force of capable apprentices, did not the conscription take all who are worth having, and keep them in service long enough to thoroughly unfit them for the workshop.

"I have four sons," said a manufacturer owning extensive works near Spandau; "one of them is in America, and is doing better than I have ever done. He had no taste for military life, and left home when he was sixteen years old, so thoroughly dissatisfied with Germany that no inducements I could offer him to remain with me had any attractions. My second son was thoroughly a soldier, caring for nothing else; so I sent him to a military academy, and he is now a lieutenant of cavalry. He is an extravagant fellow, and as it is a choice between allowing him a liberal income and paying his debts annually, I prefer the former. I hope that by the time he becomes a staff officer he will be self-supporting. My third son wanted an education. He entered the Polytechnicum, lost a year by serving as a volunteer, returned and completed his studies in the course of ship-building, and is now in England. He will never return to Germany to live. My fourth son is only eleven years old, and on him my hopes naturally center, but he has made up his mind to join his brother in America, and I shall probably have to let him go. Last year, realizing that my sons would not succeed me, I began to look about me for a young man whom I could take into the business to relieve me as I grow old. My plan was to select ten capable and promising young men, the sons of my best and oldest employés, and put them into my shop as cadet apprentices. I proposed to give them special facilities for learning the business. At the end of each year for five years the one least capable and giving least promise of future usefulness should be dropped from the cadet class and become an ordinary apprentice, or leave, as he might prefer. If, however, no one of the class failed to attain the reasonable standards of proficiency fixed by my scheme, or had done nothing to forfeit my respect and confidence,

there was to be no reduction of the number of my cadets, and I undertook to provide comfortably for all who held out. At the end of three years I was to take into the office the two young men who had shown most proficiency and capacity, that they might learn something of accounts and become familiar with business management. At the end of five years the most capable of the two who had been taken into the office was to be made my assistant and given an interest in the business as a partner; the other was to be my chief clerk, with a smaller interest, but not as a partner. Those remaining in the shop were to be promoted to responsible positions. My plan was to organize my class of cadets from those who had served one year or two years in the army and to give them each year the time needed for field practice, in order that no interruption should be caused by conscription. It was a beautiful plan."

"How did it work out?" I asked.

"It didn't work out at all. Out of probably three hundred applicants I have not yet been able to select five eligible young men who are willing to accept my very reasonable and liberal conditions. Those who have the necessary education prefer to continue students and enter professional life. Those who have not are liable to three years' service, after which I would not take them. Among the sons of my employés there is but one—or possibly two—I can accept. Both are cripples, one slightly and probably not to an extent which will impair his usefulness or shorten his life. His father is foreman of my pattern shop, and I shall probably give up my idea of a cadet class and start this young man alone in the race. However, if he had not had one leg shorter than the other, he would have gone to America with his brothers two years ago."

"Do you not find good material among your apprentices without the special selection you had planned?"

"Yes, but not much. It is so easy to get a good education in Germany that the brightest boys seldom become apprentices in the mechanical trades. Those who do sooner or later go into the army, and I rarely ever see them again. When discharged, they are too old to begin again, and did not learn enough during their first term of shop work to be of much value. I can get plenty of those who have half learned their trades. There are thousands of this class of mechanics who drift about from place to place, working in the shops where they can, simply because they can find nothing else to do. If it were not for emigration, which constantly draws off this large class and takes them where they can probably do better,

Germany would be overrun with half-skilled labor, and our condition would probably be even worse than it is.

"In a word," said my friend in conclusion, "the manufacturing industries of Germany are becoming more and more embarrassed every year by causes tending to divert labor from the mechanical trades. I can get ten educated and capable engineers for every one good mechanic I can hire. Clerks are so abundant that not half of them can find work. Every man is a soldier. If Germany had nothing to fear except from foreign enemies, we need have no cause for anxiety; but we are growing poorer every year, and every year finds us less able to market our manufactures in competition with those of other countries."

With whatever zeal and intelligence the Emperor and his counsellors may seek a remedy for this unfortunate condition of affairs, it is doubtful if one can be found which would be practicable or acceptable to the German people. It is the result of centuries of misrule and of conflicts which have implanted what seem to be ineradicable national jealousies and hatreds. France as a republic is no more cordial a neighbor than was France as an empire; in fact, as a republic she is more formidable as an enemy. Germany must at any cost continue to stagger under the burden of a military establishment which is crushing her life out. The future may find a solution for this great problem, but the present suggests none.

THE COPPER REGION OF MICHIGAN.

By F. B. Phelps.

THE "Copper Country," as it is familiarly called, is the section of Upper Michigan comprising the Keweenaw peninsula. It is somewhat sardonically styled by the effete Easterner the "Jumping-Off" place. Territorially it is entitled to this sobriquet. The traveler upon reaching its shores can go no farther without taking to the water and at the same time leaving Uncle Sam's jurisdiction. More strictly speaking, it has been the "Jumping-Off" place of geologists, mineralogists, mining engineers, capitalists, and artists for a score of years. I shall not attempt an expert or scientific description of the region, but will confine myself to those general features which interest the intelligent general reader.

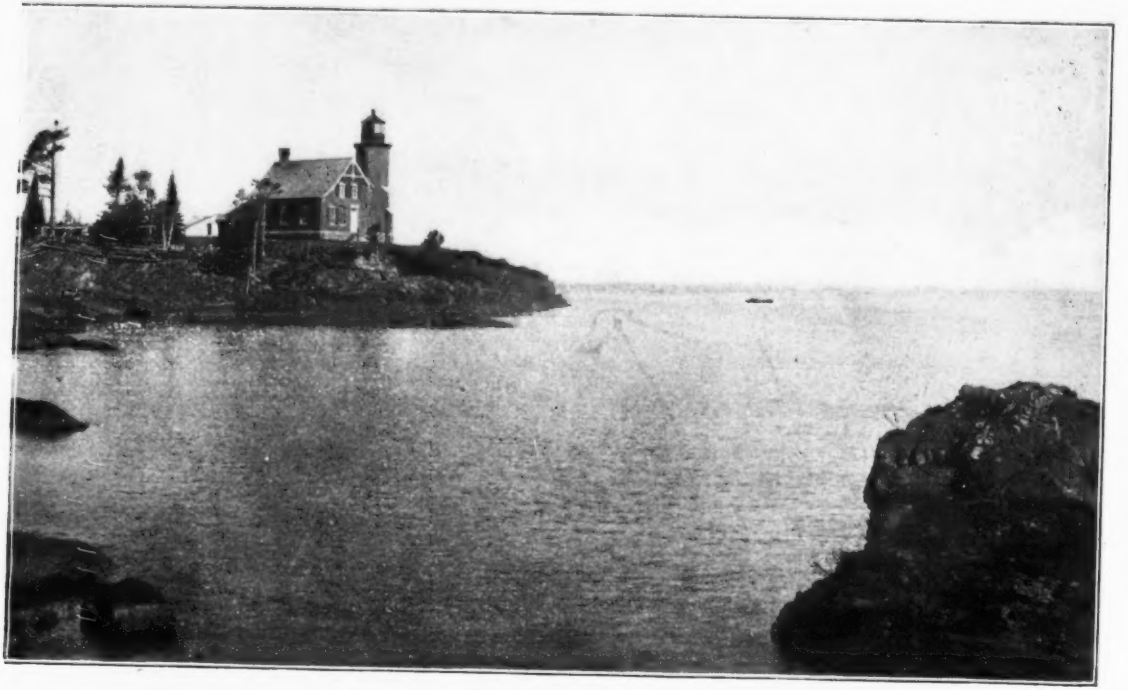
It is a territory 60 miles long, at one end pointing and breaking into a chain of islands that gradually decrease in size until they finally disappear from sight in the turbulent waters of Lake Superior. The southern extremity extends over a base of 50 miles, widening and losing its identity in the dense forests which only in recent years have been invaded by the despoiling axe of man. "Keweenaw" it is called. In Chippewa this means "Portage"; to the English-speaking world it has grown by common usage to be a synonym for "Copper."

Extending the entire length of this rocky promontory, in the form of the letter "S," is the formation which carries the only deposits of native copper of any size in the world. The geology of the region is intensely interesting, and has furnished a problem concerning which learned scientists are still at variance. The country rock is a lava known as "trap," in which are interbedded melaphyres or amygdaloids, and conglomerate beds, both of which carry the copper.

The trap is bounded on the west by Lake Superior and on the east by the Potsdam sandstone. The geological relation of the rock to the sandstone is the question which has created two opinions. It has been shown by Irving and Chamberlin that the sandstone extends under the trap. These relative positions, they claim, were brought about by an inverse fault of the trap. They give the

latter the older classification, in fact, making it the base of their geological column,—the Keweenaw division of the Archæan age. The Wadsworth school holds that the relative positions are natural,—that the trap flowed over the sandstone. In substantiation of this hypothesis it assigned the copper-bearing series a place in the Paleozoic. The economic question involved is at the present time of remote importance, as developments have shown that the workable deposits extend to immense depths.

In the northern half of the Point there are many fissure veins impregnated with copper. The commercial source of supply, however, is the amygdaloids and conglomerates. The former are lava flows in which percolating waters have deposited different minerals,—copper being the only one which possesses a commercial value. This is found in irregular forms, taking the shape of strings, globules, and large masses, very unevenly distributed. The conglomerates, as the name implies, are sea-beach deposits. Percolating water has removed the cementing mud and filled the interstices with the metal. These beds were laid one above the other in uniform width and true stratification, through successive ages. By one of those movements of the earth's crust, results of which are so well known to geologists, the greater portion of the region was submerged. By the action the Keweenaw peninsula was thrown up on the east. It is nothing more than a vertical section of the formation changed to the horizontal. It is on this outcrop, over a distance of 60 miles or more and a width of 14,000 feet, that the dozen stratified beds are accessible from the surface to the science of man. They dip westerly towards Lake Superior at an angle varying from 32° to 52°. They have been opened to a distance of 14,000 feet and found to be of a uniform width, which varies from 4 to 30 feet according to the lode. An intensely interesting feature of this formation can be studied only in connection with Isle Royale, an island in Lake Superior 40 miles long and 10 miles broad, lying 40 miles from the United States and 18 miles from the Canadian shore. It was acquired by the United States through the sagacity of Benjamin Franklin. During his diplomatic sojourn in France he learned from the Jesuits' records in the French archives that it was impregnated with copper. As a member of the commission to settle the boundary line between the United States and Great Britain he carelessly drew a pencil across the map so as to include the island. There are copper deposits thereon similar in stratification and quality to those



EAGLE HARBOR, ON THE SOUTH SHORE OF LAKE SUPERIOR.

on the main land. They differ only in their dip, which is at a less angle and easterly. Inasmuch as the Keweenaw peninsula deposits dip westerly, a most plausible theory is that one is a continuation and outcrop of the other. Granting this to be true, the 40-mile basin of the "Brother of the Sea" has a copper bottom, and the deposits are, theoretically speaking, inexhaustible.

Mining operations date from the aborigines. To-day on Isle Royale are to be found their pits and implements. The native copper found by Prescott among the Peruvian Incas, it is claimed, had its origin in this region, being passed from tribe to tribe in barter. The venerable Jesuit missionaries, Marquette, Mesnard, and Allouez, the first white men to venture along the bold rock-ribbed coast of these Eternal Waters, early learned of the existence of the metal. In 1770–72 Alexander Henry, an English explorer, encouraged by finding a piece of copper-float in the Ontonagon river, mined for copper. But his shaft was sunk in a clay-bank, and it was left for later generations, owing allegiance to the Stars and Stripes, to start a development which is now adding yearly $11,000,000 to our economic revenues. In 1841 Dr. Douglas Houghton, in a report to the Michigan Legislature of his ten years' geological and mineralogical observations in this region, sounded the tocsin which called the hardy pioneer to a wilderness accessible to the civilized world but five months in the year, and then only by long, dreary water voyage fraught with great hardship. In 1844 the first settlement was established at Copper Harbor; in the subsequent "forties" Eagle River and Eagle Harbor were founded. In 1844 the Cliff mine, the pioneer of the peninsula, was opened, and in '47 and '48 the Minesota in Ontonagon county. The industry thus started grew and prospered; villages sprang up, government roads were built, and the future seemed bright. To-day, as the tourist drives over the macadamized highways, a deserted mine confronts him at every mile-stone. Of the fifty odd locations but two are working. Whole villages stand intact, except where Father Time in his ravages has left his mark. Copper Harbor, always beautiful, once the center of pulsating life, is now little more than a hamlet, whose only institution is the Government Lighthouse. The Cliff mining location nestles at the foot of a chain of towering rocks. Not a soul is to be seen save its keeper, or an occasional farmer who wrestles a scanty living from a soil hardly warmed through by a climate that is seven months winter and five months late in the fall. A veritable

HOUGHTON IN THE FOREGROUND—HANCOCK BEYOND PORTAGE LAKE.

"Deserted Village" truly! whose only institution, entirely in keeping therewith, and yet completely modern, is the little cemetery which lies under the shadow of its "everlasting hills."

The cause of this disintegration is easily explained. The industries were built by revenues that came from certain deposits which were soon exhausted. At the time copper sold at fabulously high prices. The civil war took from this region the best workers: the patriotic are always the best. Prices fell. The region did not keep pace with the scientific developments in the mining world, and a gradual exodus to Houghton county, 20 miles to the south, took place. But two mines, the Central and Copper Falls, continue in operation, a monument to past greatness.

It is in the Houghton-county region that the copper-mining industry of Michigan has reached its present high state of development. Within its boundaries are the Atlantic, Franklin, Huron, Kearsarge, Osceola, and Quincy amygdaloids, and the Calumet & Hecla, Peninsula, and Tamarack,—conglomerates,—all of which are producers. In addition there are many promising properties, now idle from various causes. All the mines with the exception of the Tamarack, of which separate mention will be made, are worked on the same general plan. Shafts are sunk at stated distances on the angle and foot-wall of the lode. Levels are run between the shafts every 100 feet. The walls of the lode are very distinctly marked and also very even, rendering conditions for symmetrical mining almost perfect. These shafts in a number of notable instances have reached immense depths, necessitating heavy machinery. The various properties are in possession of plants which have seldom been excelled in point of size or efficiency. Until recently electricity was an unknown element in furnishing power. It is being introduced by some of the largest mines, and if it demonstrates the efficiency claimed it will undoubtedly be substituted for steam and air in certain kinds of underground work. The power used in drilling and underground hoisting is compressed air. The ventilation is by means of down and up cast drafts. The system is so perfect that depth does not affect the temperature. The writer on a visit to the bottom of the Tamarack shaft, 2800 feet deep, found the air as pure, dry, and warm as that of the beautiful spring weather reigning outside. Each mine is provided with a milling-plant, at which the copper ore, or "rock," as it is provincially called, is concentrated. Salient features of the various mines are typified in the larger. Mention will be

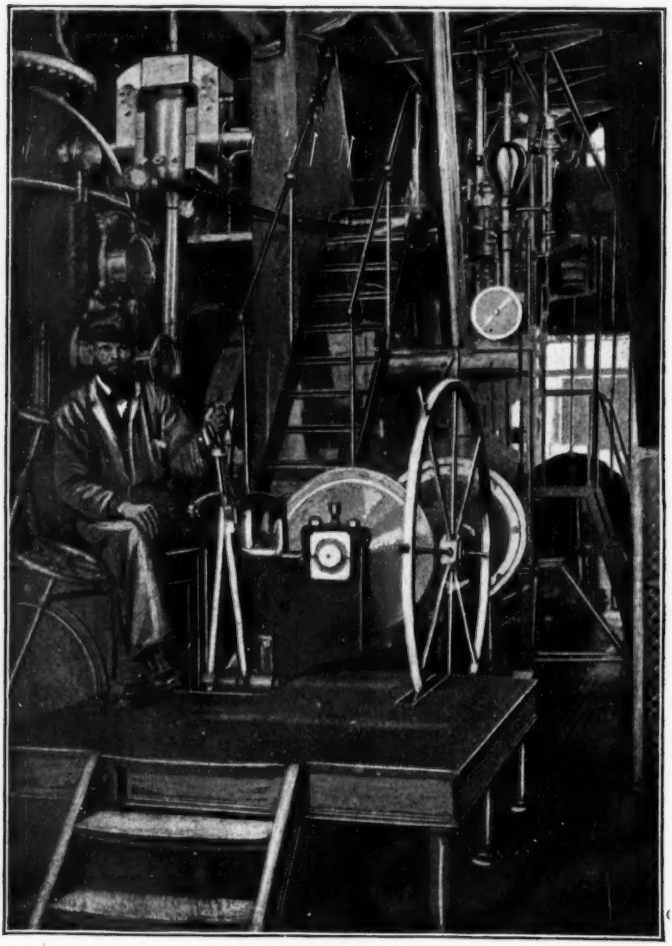
CALUMET MINING LOCATION.

HUNGARIAN FALLS, NEAR TORCH LAKE.

made of three which supply more than three quarters of the output of the region.

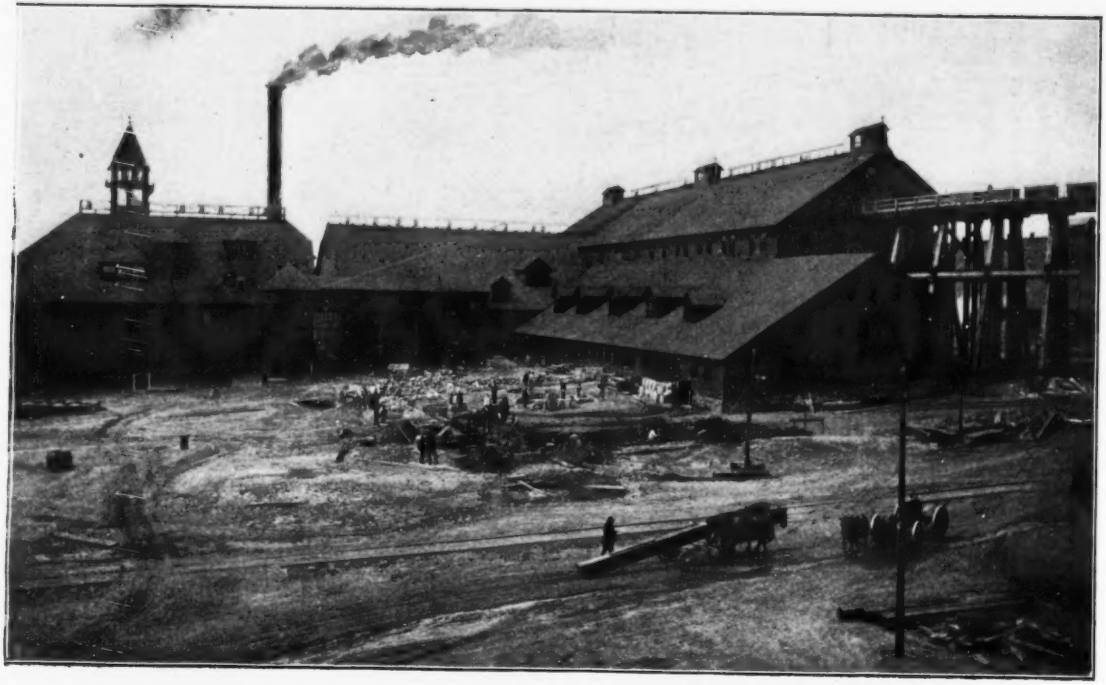
Calumet & Hecla, "Peace and War," a monument to Agassiz's sagacity, inseparably associated in the public mind with "bonanza," for obvious reasons commands first attention. Nearly every reader in the scientific world has heard of the property, either in a general or specific way. It is a tale that can be retold with ever recurring interest. To handle it thoroughly would require a volume. It was discovered in 1866 near the center of its present workings. At the time the spot was in the heart of a wooded wilderness, broken only by a trail from Portage Lake to Copper Harbor. The story of its discovery, to a degree authenticated, is to the effect that a camping party, noticing a pig rooting in a shallow excavation, which was afterwards proved to be a pit dug by a prehistoric miner, made investigations which were rewarded. It was brought to the notice of the world by Mr. E. J. Hulbert. At the time there pre-

VIEW OF THE CALUMET MILL, FRONTING EAST.



THE SUPERIOR OR "JUMBO" ENGINE.

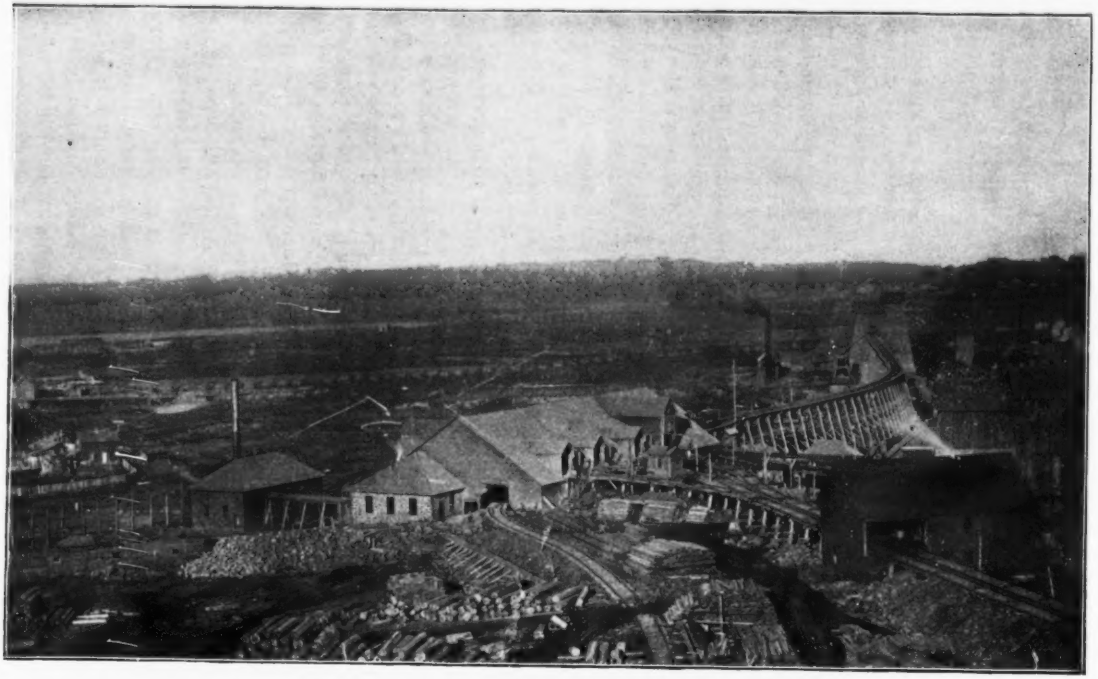
vailed a popular belief that native copper could not be found in paying quantities in conglomerates, all the prosperous mines up to this date being in amygdaloid deposits. For a considerable period its 20,000 shares led a beggarly existence. Development



VIEW OF THE HECLA MILL, FRONTING WEST.

demonstrated its value. It is now capitalized at 100,000 shares, par $25. Its stock quotation is now $290 per share, and has been as high as $315. Since its start in 1866 it has paid $39,000,000 in dividends. The mine is located in the conglomerate which bears its name and shares its celebrity. Its lode outcrops over a surface of 14,000 feet. Along this entire distance is the solid chain of buildings provided for its equipment.

This can be pronounced the most elaborate mining machinery in the country. The lode is from 8 to 30 feet in width, averaging about 12 feet. There are 2400 cubic fathoms of copper-bearing rock to the acre. The yield of copper is 1300 pounds to the cubic fathom. There are 1300 acres of unexploited mineral land. Reader, figure out its resources! There are 18 shafts on the property. The greatest depth reached is the fortieth level, or 3850 feet on the incline, or about 2350 feet vertically. As the ore is mined its hanging walls are supported by stulls, or heavy pieces of timber. These, in places, are as thick as trees in a dense forest. For 25 years these timbers have been put in place until there is now sufficient lumber underground to build a town of the dimensions of the mine. Conceive a city nearly three miles long, half a mile wide, with 18 avenues and from 20 to 30 cross streets, located on a hillside that pitches at an angle of 38°, and you have a very fair idea of just what the Calumet & Hecla mine would be if its timber were framed into houses. It was among these timbers in 1887, and a second time in 1888, that the fires broke out, necessitating a shut-down of several months in each instance. They burned until all the combustible matter in reach was consumed, or until the rising water smothered the flames. In addition to these openings, the company has followed the example of the Tamarack, in sinking a vertical shaft. It is 15½ x 25 feet in dimensions, and 5000 feet west of the outcrop, on a line with its dip. It has already been cut by a 1700 ft. cross-cut from the 36th level of the No. 4 incline shaft of the old workings. It is now being continued to the lode, which it will cut at a depth of 3400 feet. This shaft has been equipped with a most elaborate complement of machinery, and when in full operation will greatly increase the capacity of the mine. The largest piece of the company's machinery is the Superior engine, styled in local vernacular "Jumbo." Its estimated horse power is 4300; it develops a working capacity of 2300 under a high steam pressure. Its cylinders are 5 ft. 10 in. and 3 ft. 6 in. in diameter, and its weight 350 tons. It is generally



VIEW OF CALUMET SHAFTS, NOS. 4 AND 5, LOOKING NORTH.

acknowledged that it is not a success, being too large and complicated a piece of machinery for mining work. There are 8 or 10 different hoisting plants on the mine. A brief description of one will convey to the reader an idea of the others. This consists of three engines, "Houghton," "Seneca," and "Fontenac." They are of a triple expansion, vertical inverted beam type, designed to hoist 10 tons at a speed of 2000 feet per minute. The cylinders are respectively 18, 27¾, and 48 in. in diameter, all by 7 ft. 6 in. stroke. Each is provided with four gridiron valves, worked by independent cams, so made as to utilize the cut off. The hoisting system is the constant-motion, non-reversing, friction type, the drum rotating with the engine shaft when hoisting and on the shaft when lowering. The drum is conical, 27 ft. diameter at one end and 14 ft. 7 in. at the other, with a spiral groove capacity for 5500 feet of 1¾ in. wire rope. The engine, by an automatic device, varies its speed from 30 to 45 revolutions per minute, thus hoisting at a uniform rate.

The method of mining is similar to that in vogue in other districts. The stoping is mostly breast and rising. The cars are trammed to the hoist by hand. After the rock reaches the surface it is dumped on an elevation, sorted, and dropped through a series of crushers until it is reduced to the size of egg-coal. From the bins in which it is placed it is dropped into cars for transportation to the milling plants. The plant of the Calumet & Hecla is located on Torch Lake. It is of the same gigantic proportions as the other equipment. The mills are two in number and cover with auxiliary buildings 30 acres of ground. The stamps into which the rock is fed by means of gravity are 18 in number. The capacity of each is 250 tons of rock for 24 hours. As this rock is reduced it is forced through a $\frac{3}{16}$-inch mesh screen by water, which carries it through a series of hydraulic separators, in which the heavier particles of copper are deposited; the slimes are lastly conducted to a table about 15 feet in diameter, which has every appearance of a gigantic parasol, with the exception that the surface is not ribbed. By a series of water jets the waste is thrown off and the mineral retained.

In connection with this plant is the full complement of machinery. The gigantic pumping engine "Michigan," capacity 40,000,000 gallons of water per 24 hours, commands attention, as do the four sand wheels. The largest wheel is 54 feet in diameter. On its rim are 432 teeth, 4.71 in. pitch and 18 in. face. Its utility is

CALUMET SHAFT NO. 1 AND HECLA SHAFT NO. 1.

[The trestle shown supports the wire rope, transmitting power from the Superior engine.]

self-evident to the observer. The immense amount of tailings or sand waste, owing to the fall in its successive treatments, leaves the mill very near the ground surface and would soon bury the plant were it not cared for. The wheels receive and elevate it to a height of say 50 feet, and throw it into a launder, by means of which it is deposited at almost any desired distance. The problem of disposing of this sand is one which has troubled the mining companies from the start, and necessitated the removal of several mills to more advantageous points. One authority estimates that the sand deposited by the Calumet & Hecla mill in a day covers 1½ acres of ground 2 feet deep.

The Tamarack, the next to the largest mine of the district, is an outgrowth of a bold conception carried to a successful issue. John Daniell conceived the plan of sinking a vertical shaft at a point beyond the Calumet & Hecla boundaries, for the purpose of tapping the Calumet conglomerate bed, which he had reason to believe could be reached at a point west—the direction of its dip—by a shaft of sufficient depth. Title was acquired to 1280 acres of land in the mineral belt by the Tamarack Mining Company, and the shaft was started in February, 1882. In June, 1885, three and one-half years later, the most sanguine expectations of the management were realized. The lode was cut at a depth of 2270 feet. An extraordinary undertaking, that of sinking a hole half a mile into the earth with no positive assurance that there would be returns for the two hundred thousand dollars that must be expended! To quote the language of a recent writer: "It was a radically bold project, thoroughly reasoned out from its inception, and rapidly, economically, and successfully brought to a conclusion." Through it many economic results were obtained. It added to the world's wealth vast stores of copper deposits heretofore inaccessible. It showed to the Calumet & Hecla, whose property, strictly speaking, lies above, that the latter had in store vast quantities of ore rich in copper, the nature of which up to this time was little more than a matter of speculation. Among all persons interested in the geology of the country, in the problems of mining, in the values of stocks, it disseminated information that was invaluable. It gave an impetus to mining and enhanced values, inasmuch as it demonstrated that copper deposits existed in paying quantities at great depth, and showed new, successful, and economic ways of working them. The mine became a dividend-payer from the start, and up to date has distributed $2,970,000 among stockholders. The success of the

first shaft led to the sinking and completion of a second, while within the past three years two more have been started. These latter have not yet reached the lode. The capitalists owning this mine, under the corporate name of the Tamarack Jr. Mining Company, are sinking two shafts on the same vertical plan on 120 acres of property north of the Tamarack and separated therefrom by the Calumet & Hecla possession. One of these shafts recently reached the lode.

As an amygdaloid mine the Quincy, the third in the district in amount of product, commands notice as typical. It is located on a bluff overlooking the villages of Hancock and Houghton, which are on either side of Portage Lake. Mining operations were begun in 1853 and continued without interruption. To-day the property is quoted at $6,250,000, and has distributed to the stockholders $6,400,000 in dividends. There is very little to be said apart from the general description preceding. Its only varying feature is its amygdaloid ore, which is much softer than the conglomerate. The method of working, however, is the same. The Osceola and Atlantic are two very excellent amygdaloid properties. The latter pays a dividend of one dollar per share per year from a rock yielding $\frac{7}{8}$ per cent. copper. A number of other mines of the district are important factors. Just at the present time, owing to the low price of copper,—viz., 11½ cents per pound,—there is very little development of new and non-producing properties, while a number of old mines have recently closed down.

An industry which is a direct outgrowth of the mining interests is the Tamarack-Osceola Manufacturing Company, located at Dollar Bay. Five years ago the site was covered by a forest. To-day it is a village of perhaps 2000 inhabitants, and contains copper rolling and wire mills and smelting works. It is controlled by capitalists who own the mining companies whose names it bears. Its products compete in eastern markets.

The smelting plant of the company where the mineral is refined consists of 14 reverberatory furnaces with auxiliary cupolas for the resmelting of the slags. The shore of Torch Lake, over a distance of 3 miles, is lined with docks, railroad terminals, and other equipment of the company. It is the point at which the mine receives and ships its water freight. It owns a standard gauge railroad 9 miles long, the majority of the real estate in Calumet and the adjoining town of Red Jacket, and a hundred and one other institutions which are always to be found with so extensive a plant.

HOW WE CAN GUARD AGAINST CHOLERA.

By George F. Shrady, A. M., M. D.

CHOLERA is endemic in India ; that is, it always exists in that country, from year to year, in winter and summer, and propagates itself thence to all parts of the world. It is looked upon by the natives very much as we look upon malaria ; a man dies with it, and that is the end of it. They calculate a regular rate of mortality from this disease in India of something like 250,000 a year. The cause of cholera is dependent upon a bacillus, which was discovered in 1884 by Dr. Koch, of Berlin, who was chairman of a commission sent by the German Government to investigate the epidemic then prevailing in Egypt. The home of this bacillus is the delta of the Ganges, a locality notorious for rank vegetation and bad drainage.

Strictly speaking, cholera is an infectious rather than a contagious disease. By the latter term we mean that the poison is conveyed from one individual to another by other means than direct contact. Many theories have been advanced as to the probability of the transmission of the cholera germ through the air, but nothing has been proved. On the contrary, the sum of all investigations has brought scientific men to the agreement that cholera can be produced in the individual only through the introduction of the bacillus into the alimentary canal, and that it can be communicated to another only by means of the ejecta—vomit, feces, and urine—from the infected person. The principal media for such transmission are soiled linen, contaminated food, and drinking-water. We can allow of the possibility of the discharges, from the neglect of cleanliness, coming directly or indirectly in contact with the mouth in many ways which it is hardly necessary to enumerate. The propagation of cholera allies itself very much to the method of transmission of typhoid fever by the typhoid bacillus,—through drinking-water.

When the bacilli once find their way into the alimentary canal, their reproduction is rapid. Millions are produced in a very little while, almost in a few moments. As a result, the intestinal canal is irritated, and diarrhea and vomiting follow. Then a new condition obtains, in the exfoliation, or scaling off, of the lining mem-

brane of the intestines, which partly explains the "rice-water" discharges. The first stage of cholera is the irritative one, the next is the destructive one, and the last is the poisonous stage, in which virus is obtained as the result of multiplication of bacilli in the intestinal canal. When this toxic element attacks the nervous system, collapse is produced. In the meantime the blood suffers a loss of its watery element through the discharges, and it becomes too thick to circulate. All these symptoms can go through the various stages in from one hour to twenty-four or more.

Prevention is the most important point in dealing with cholera, because there is no remedy yet known as a specific for this disease. Each case has to be treated upon its own merits scientifically, as we would look after the gradations of typhoid fever. The most unfortunate thing is that cholera is so malignant and overwhelming in its attack that there is often no time for any treatment to have any effect. The lesson to be learned, then, is that of preventing the entrance of the disease, by means of quarantine, for the country at large, and by attention to the laws of hygiene and good drainage in each locality. There is nothing that demonstrates the utility of free drainage in any epidemic more than in that of cholera; and it has been due to sanitary science, and to those men who have worked in that line, directly and indirectly, that the causes of the propagation and prevention of cholera have become known. In following out the idea that this is essentially a disease having its origin in filth, it has been proved that wherever the water-courses of India have been improved, and the sanitary requirements have been met more or less fully, the disease not only has been abated in its severity, but in some cases has been stamped out entirely. It is notorious that the English officials in India, and those belonging to the English army there, having good sanitary regulations, are as a rule not susceptible to cholera, though it might be expected that these unacclimated classes would suffer from it more than the natives. Could a stronger point be made on the value of sanitary science in its bearing upon the public health?

It has been abundantly proved that the cholera poison is carried more by water-courses than by any other means. In large streams the method of propagation is by carriage of vessels; in small streams by pollution of the water. Many epidemics have been traced to the latter source alone. The ejecta happening to find their way into a water-course which supplied drinking-water a few miles down-stream has often resulted in the outbreak of an epi-

demic among those drinking the water. Moral: boil your water, because it is known that the boiling temperature kills the bacilli. On the contrary, they are not entirely killed, although rendered more or less quiescent, by extreme cold, as they have been known to last during an entire winter and the following season start an epidemic afresh.

The idea of maritime quarantine we owe to the Italians. At an early date the merchants of Venice began to associate sudden outbreaks of disease with the arrival of foreign merchant-vessels, and as a measure of precaution concluded to put restrictions upon their landing. The period of detention was at first made forty days, in an arbitrary way, whence the term quarantine, from *quaranta*, the Italian for forty. Experience has shown that quarantine, if absolute, is effective against disease. Unfortunately, however, perfect protection is not always possible. The many ways in which the strictest quarantine can be oftentimes evaded, the numerous avenues through which a plague may enter our unprotected land-routes, the difficulty in educating the public to a proper sense of responsibility in protective measures, the pecuniary interests that are in direct antagonism to the restriction of personal liberty in travel, and the pressure to overcome the necessary hindrance to commercial transfers, are factors which weigh with the greatest possible force against the best intentions of the most trustworthy officials. To show that quarantine can be effective, it may be said that in the eighteen cholera epidemics in the Staten Island Quarantine, during the whole history of its maintenance, only four reached New York city. The quarantine at New York is the most perfect, perhaps, of any along our coast. More money has been involved in keeping it up, and more lives and more interests are at stake there than elsewhere.

Quarantine must, in the first place, not only stop infected persons and goods from entering any port, but must destroy the poison when it approaches the port and not permit it to get in further. For that reason we have quarantine hospitals. Persons who are not infected but who have been exposed to infection, on the ships or abroad, before sailing, are placed under inspection until the time of the incubation and development of the disease is passed. The quarantine, to be absolute, must completely encircle and control the infected persons; secondly, it must protect the exposed persons by separating them from the infected ones. On general principles it is dangerous to have infected people and exposed people on the

same vessel for any considerable length of time, because under the best of sanitary regulations the disease may spread on board ; it certainly is more apt to spread than if the two classes were separated in hospitals a mile or more apart, with every means for destroying the bacilli. The only safe way is to kill bacilli on the spot, wherever found,—to stop them where they are, to give them no soil to grow upon, as well as to destroy the seed. Thus clothing should be boiled and disinfected, the hands cleansed immediately after exposure to infection, all food boiled before it is used, and everything eschewed that cannot be boiled. All these precautions may be observed on a ship, it is true, but the passengers who are exposed are much safer when they are removed.

In reference to the difference between State rights and Federal rights, in times of danger it strikes me as always well to give the benefit of the doubt in favor of the longest quarantine and the greatest power to enforce it. And even if a good local quarantine is the most efficient in any case, it is well, as a precedent for others, to establish the right of the Federal government, in times of supreme danger, to extend it or to modify it in any way that it chooses. That makes the quarantine uniform and efficient—especially along sea-coasts so extensive as ours, and where so many interests are at stake—in preventing any particular ship from running between ports and allowing the disease to spread. No other force can command the coast so fully as that of the National Government.

The inland quarantine is only to be effected properly by an understanding and coöperation of the different peoples along the line of communication,—that is, the boundary. The United States has no power without a treaty to establish an effective *cordon sanitaire*,—a line of soldiers that would prevent people from going over the border. But an understanding between the parties—in Canada and New York, for instance—could probably be effected and carried out without interfering with commerce or the liberties of the people. But it has generally been found that such sanitary regulations on land have amounted to very little practically. The idea of quarantine is to confine a thing within a locality, absolutely, and when that can be done, it is effective ; when not, it is a farce.

Cholera was such a dreaded scourge in the past because it was so little understood. Comparing our present knowledge with what was formerly believed, we are almost in a condition to stamp out the disease rather than submit to it. We have made decided

progress, and more in the sanitary lines than in any other bearing upon cholera, except the discovery of bacilli as the cause. The means of its propagation and its control belong to the field of engineering and sanitary science, which is a reason why the readers of this magazine should be especially interested in the subject. The sanitarians (who are also doctors), the civil engineers, and those who have made the betterment of cities their study, have done more to put this disease under control than is generally appreciated.

During the period that the Board of Health of New York has had control—that is, since 1866—the sanitary condition of the city as regards drainage, the disposal of sewage, and the ventilation of dwellings has steadily improved. While we have a very dirty city, due in a great part to the indisposition on the part of ignorant inhabitants in the densely-populated portions to follow out the directions of the authorities, the household hygiene has increased up to almost as much perfection as we can dare hope for in a free community that naturally resists directions of health authorities. For instance, we are ventilating our sewer-pipes. The old systems of drainage have been replaced by the order of the Health Board. No man puts up a new building now without conforming to the scientific regulations of the Health Board as to drainage. The drainage of a house is of as much importance as the thickness of the walls or the depth and solidity of the foundation. In household hygiene, considering the youth and the rapid construction of the city, New York is in a better condition than any other city of its size in the world. While not so much can be said of the streets, the city as a whole is in a better condition to cope with an epidemic of cholera than it ever was before.

There is also a good deal of system about the Health Board in regard to reporting and caring for contagious diseases and removing patients to hospitals. All of this gives a guarantee of protection from a formidable epidemic, which should impress people that New York would probably be safer in such an emergency than any other part of the country, on the same principle that a soldier in a well-garrisoned fort has a better chance to win a fight than in the open field. The experience of the Health Board in dealing with small-pox is a triumphant demonstration of its effectiveness in dealing with contagious disease.

The consensus of opinion of observers over wide fields is that the greatest danger from cholera exists where there is a defective

subsoil drainage. This was first demonstrated by the distinguished Pettenkoffer, who found, in 1866, that in all cases where cholera existed this condition of the soil was present. The typical results were manifest when there was a porous soil on the surface with a hard bottom but a little distance down. This discovery was previous to that of the bacillus, but it was in the right direction. Other conditions favorable to the virulence of an attack of cholera are those of a thickly-settled residence district and associated filth, especially if there should be high temperature, low barometric pressure, and much humidity. All other things being equal, villages having the greatest proportion of ignorant people are apt to suffer most. Not only is it wise, but it is the duty of health and other authorities to put cities and towns into the best possible condition for resisting an epidemic, without awaiting its appearance.

There is one class of individuals upon whom rests a responsibility no less, perhaps, than that resting upon the public officials,—the heads of great industrial and transportation enterprises, whom we sometimes call our "Captains of Industry." The requirements of a vast railroad system or of an enormous manufacturing plant are such that the superintendents practically control the time and the movements of thousands of employés, who are not free in a time of danger to seek places of safety from infection; they may not be free to select their places of residence at any time. On common economic grounds, if no higher considerations prevail, the owners of these large concerns would do well to keep in mind at all time precautions for the health of their workmen, seeing to it that their surroundings are in the best possible condition. An epidemic would demoralize a factory more than any strike; yet large manufacturers, in guarding against strikes and in overcoming them, spend far more money than would serve to put all the great manufacturing districts—including both the mills and the workingmen's homes—in first-class sanitary condition. I have been informed that one of the largest factory communities in America has been built upon land which was first voluntarily put into the best possible hygienic condition by the company before a single workingman's home was built there, but it is safe to assert that this is exceptional. Yet I know that these employers of labor as a rule are inclined to be fair to their employés, and I believe that any appeal to them is sufficient when they see the utility of it. I have often spoken to some of my friends who are extensive employers of men, and have been quite interested to know how they

manage things. The result is that I have been impressed with their desire to put their employés in the best possible relations, and make them comfortable, happy, and—most of all—healthful. Hence I think that the suggestion here outlined need only to be properly placed before manufacturers to secure their coöperation in the work of sanitation.

The means to the end are simple: a perfect drainage, on general principles; in cholera, boiling the water and boiling the food; destroying germs of disease at once, and at the bedside of the patient; and taking care to prevent the spread of infection from the corpse itself. Then, too, comes up the question whether cremation would not be better in epidemics, for fire absolutely destroys everything. But if bodies are buried, it should be as far as possible from any source of water-supply. As for clothing and furniture, it is best to have them not only disinfected thoroughly with bichloride of mercury or by boiling, but burned also.

The question of cholera is one with which we may expect to contend for a great while yet. There is no guarantee that for the next two or three years, as a result of the present epidemic in Europe, cholera may not come at any time and be knocking at our ports. Really, we must always be on the watch, so long as it exists in India, and so long as travel comes even indirectly from that country to our own. Seemingly there is no means of stamping it out in India. The British Government has attempted to do it by instituting sanitary improvements at places, with good results, but the main source is still unattacked. There may be peculiar atmospheric and other conditions that are not yet known which govern the spread of this epidemic. Thus it is not fully understood why, although the disease is ever prevalent in India, it should sweep around the world in virulent form only at irregular and sometimes long intervals. We may generally assume that an epidemic passes over a continent very much like a wave of wind. It has so long a blow, and when blown out it passes away, and a new wave in time takes its place. Each epidemic has its own law as to duration. Some have been known to continue for two or three years. But an epidemic is not apt to occur in successive seasons in affected localities; not apt to occur, I say, but it sometimes does. It is more apt to go from one region to another, all things being equal. We cannot tell why it is.

Finally, fear, even among the most intelligent classes, has a very strong predisposing influence. In fact it is considered to be one of

the prime subjective factors in propagating an epidemic. I do not see why it should, except that it carries a depressing influence of the vital forces. That brings me to say that the healthy individual in any epidemic is always the safest. He can resist morbific influences the best, and it seems unphilosophical to suppose that we prevent the cholera by extraordinary care and restriction in diet. There is as much danger in too much restriction as there is in too much indulgence, for the reason that there may be interference with the nutrition, thus lessening the power to resist the epidemic when it does come; and then we must understand that there is no condition of food, or bad drainage, or any other influence that of itself can bring about an invasion of cholera independent of this little microscopic bacillus; that must always be there. The bacillus is the seed, and when you have the seed and the soil, and the requisite conditions properly associated with them, you have the rank growth. I think that is the idea that everybody should keep in their minds in estimating the chances of the spread of the epidemic.

HOW ELECTRICITY IS MEASURED.

By Herbert Laws Webb.

AMPERES, ohms, and volts have almost become household words. In the newspapers they are to be seen every day, and since applied electricity has almost reached the prominence of a popular cult, the literary and semi-scientific journals handle the terms peculiar to the science with a seeming confidence in the ability of their readers to understand them that too often is misplaced. Very many intelligent persons have not yet had occasion to learn what amperes and ohms and volts mean to the electrical engineer and how he makes use of them. They are the fundamental electrical units, and a clear understanding of what they represent and their relations to each other is an indispensable preliminary to any inquiry into the fascinating subject of electrical measurements. The relations between the volt, the ohm, and the ampere are fixed and immutable, and on these relations depend the remarkably accurate calculations and measurements that the workers in electrical science have evolved.

The volt is the unit of electrical pressure, or, as it is often called, electromotive force. The ordinary Daniell battery, containing zinc and copper elements in solutions of zinc and copper sulphate, gives an electrical pressure of one volt; in other words, the pressure available between the two poles of this type of galvanic cell was adopted as the unit of electrical pressure and was named a volt, after Volta, the renowned Italian physicist.

The ohm is the unit of electrical resistance. All bodies offer a certain amount of resistance to the passage of an electric current. Those which offer a very high resistance are termed non-conductors or insulators, and those which offer a relatively low resistance are termed conductors. The insulators comprise such substances as glass, porcelain, vitreous and bituminous materials, india-rubber, gutta-percha, oils, and gums. The best conductors are the metals; water and solutions of salts and the human body are fair conductors. In order that the resistance of different conductors might be measured or compared a standard or unit of resistance had to be determined. This was named the ohm in honor of the German scientist who gave to the world the laws of the electric

circuit. A column of mercury a fraction over 106 centimeters long with a cross sectional area of one square millimeter has a resistance of one ohm. A copper wire of the same sectional area and having a resistance of one ohm would be about sixty times as long as the mercury column, as copper is a much better conductor than mercury. The copper wire generally used for telephone- and telegraph-lines has a resistance of a little over four ohms to the mile. An iron wire of the same size would have about six times the resistance, as iron is a much poorer conductor of electricity than copper. Iron wire is used as an electric conductor only for telegraph-lines; its cheapness and strength recommend it for this work, but even for telegraph-lines copper is replacing iron to a great extent. In the distribution of electricity on a large scale copper is used exclusively, as it is for the coils of almost all electrical machines and instruments.

The ampere is the unit of current strength, and is so named from a French electrician. If a source of electricity having a pressure of one volt be connected to a circuit having a resistance of one ohm, the current that will flow in that circuit has a strength of one ampere. The ampere is derived from the volt and the ohm, and in order to produce amperes we must have volts acting upon ohms. A certain number of volts acting on a circuit containing a certain number of ohms *must* give a current of a certain number of amperes. If we have ten volts acting on one ohm we get ten amperes of current flowing in the circuit, and if we have one volt acting on one-tenth of an ohm we get ten amperes, while if we have one hundred volts and ten ohms we get ten amperes. Wherever an ampere is needed a volt must be available for every ohm of resistance to force it through the circuit. Wherever a path is open to the current it will flow through that path in exact proportion to its resistance, and the strength of the current will be proportional to the pressure that drives it. Take for instance an electric-light circuit. The type of incandescent lamp in most general use requires a current of about half an ampere to heat the filament to incandescence. Consequently we see that the resistance of the lamp must be twice as many ohms as there are volts of pressure in the circuit. With 110 volts pressure a lamp having a resistance of 220 ohms will allow half an ampere of current to pass through it. If the pressure is allowed to diminish, less than half an ampere of current will pass through the lamp and the filament will grow dull; if the pressure is increased the flow of current will increase and the

filament will get brighter. The flow of current, then, is dependent always on the pressure developed at the source of electricity and the resistance of the circuit to which that source is connected. If, for instance, in an electric-light circuit where an unvarying pressure is maintained and acts on relatively high resistances of over 200 ohms, a path of very low resistance is suddenly provided by some accidental crossing of wires or rupture of the insulation, there will be an immediate rush of current through this low resistance ; the lamps will be extinguished and the heating effect of the many amperes of current that will be concentrated at the point of very low resistance may melt the wires and set fire to any inflammable material within reach.

There is one other important electrical unit, which has been adopted of late years, since the distribution of electricity on a large scale for lighting and power has become so general, and that is the unit of electrical power. This is called the watt, and its value is the power developed by a current of one ampere at a pressure of one volt. In other words, one watt is an ampere multiplied by a volt. An incandescent lamp consuming half an ampere at a pressure of 110 volts takes 55 watts of electrical power. The watt is such a convenient expression that almost all expenditures of electrical power are now expressed in watts, or in kilowatts. A kilowatt is one thousand watts and is equivalent to about one-and-one-third mechanical horse-power. A dynamo is said to be of so many kilowatts capacity ; and the kilowatt-hour—that is, one thousand watts for one hour—is the standard unit of current supply in England and serves as a basis on which current is charged to the consumers.

The effects produced by the electric current are manifold, but a general classification may be made of the different methods of converting electrical power into some other form under three headings,—electro-magnetism, electrolysis, and heat. If a current be passed through a wire placed in proximity to or coiled around a magnetized needle, the needle will move, and every change in the continuity, direction, or strength of the current will be accompanied by a movement of the needle. Similarly, the movement of a steel magnet near a coil of wire will produce a current in the wire ; and again, if a wire be wound round a soft iron bar and a current be sent through the wire, the bar will become magnetized. When the current ceases the bar returns to its inert state, to return to power directly the current is turned on again. To this close relation

between electricity and magnetism are due the galvanometer and many other forms of electrical measuring-instruments, telegraph instruments of all kinds, the telephone and the dynamo and electric motor.

If a current of electricity be passed through a solution of any metallic salt between two metal plates suspended in the solution, the salt will be split up into its component elements and metal will be dissolved from one of the plates and deposited on the other. This process is termed electrolysis. It is governed by fixed laws by which we know that a current of a certain strength will deposit exactly so much of any given metal per second, minute, or hour. Electrolysis or electro-deposition is used extensively in the arts for electroplating and electrotyping and for refining of metals from their ores.

The conversion of electricity into heat takes place to a certain extent in all electric circuits. As we have seen, all conductors offer a certain amount of resistance to the passage of the current, and the work done in overcoming this resistance is manifested in the heating of the conductor. When the conductor is intended solely *as* a conductor, its resistance is made so low that the heat generated is slight enough to be readily disposed of by radiation. When, however, it is desired to turn the heat that the current is capable of developing to good account, a high resistance is interposed. The incandescent lamp is an example of the conversion of electric power into heat; in overcoming the resistance of the carbon filament the current heats the filament to incandescence. In the arc lamp heat is developed by the resistance at the contact of the carbons, and the arc is sustained by the vapor of carbon produced between the two points. In many other applications of electricity heat is generated intentionally and for a useful purpose, but the two examples given in electric-lighting are those with which the world has become most familiar.

In the various, or one might say multifarious, methods devised for the execution of electrical measurements of different kinds, use is made of the three effects of electricity described above,—electromagnetism, electrolysis, and heat. The primogenitor of all electromagnetic measuring-instruments is the galvanometer. In its simplest form the galvanometer consists of a coil of insulated wire in the center of which is pivoted a magnetized needle. To the spindle which carries the needle is attached above the coil a light metallic pointer which moves over a graduated scale. The more del-

icate the balance of the needle and the greater the number of turns of wire in the coil the more sensitive the galvanometer. The most sensitive type of galvanometer is that invented by Sir William Thomson, in which the needle is very small and is attached to a tiny mirror about the size of a dime; the mirror and needle are suspended within the coil of wire by a single silk fiber, and a spot of light, reflected by the mirror from a lamp back to a paper scale placed about three feet from the instrument, serves as the pointer. The slightest movement of the needle is accompanied by a very appreciable deflection of the spot of light on the scale. This instrument was designed originally for transmitting signals through the Atlantic cable, and it was used on all long cables for many years, until the syphon recorder, which marks the signals on a continuous strip of paper, replaced it.

The galvanometer is used in making electrical measurements both by comparison and directly. For instance, in measuring the resistance of a wire a current is sent through the wire to be measured and through a set of standard resistance coils whose resistance is known and can be adjusted at will. The current has two paths open to it, one along the conductor whose resistance is to be determined and the other through the coils whose resistance is known. The galvanometer is so connected that it will show by the deflection of its needle which path absorbs the most current. As we have seen already, the flow of current is proportional always to the resistance of the circuit, so that what must be done is to vary the resistance of the adjustable coils until the galvanometer needle remains stationary. That will indicate that the current flowing through the two paths is equal; therefore the resistance of those two paths must be equal, and as the resistance of the adjustable coils is known, the resistance of the conductor is found by reading off the number of ohms in circuit when the balance is obtained. This is one of the simplest of electrical measurements and can be performed with extraordinary accuracy, the resistance of conductors being determined down to one ten-thousandth of an ohm. The method of carrying it out can be compared to the simple act of weighing. The balance takes the place of the circuit having two branches, the pointer being the galvanometer at their junction; the material to be weighed is the unknown resistance and the weights the adjustable coils whose value is known, the attraction of gravity supplying the place of the current which permits the comparison to be made. The weights are

adjusted until the pointer shows equality (just as the coils are adjusted until the galvanometer needle remains at zero), and the weight of the substance is then known by the value of the weights used in obtaining a balance.

In many cases electrical measurements are made by comparison with standard values, as in the example just given, the galvanometer being the indicator which serves as a means for establishing the comparison. In measuring electrical pressures, for instance, comparison is made with a standard cell whose pressure or electromotive force is known. Direct methods of measurement are also available, and of course for the commercial measurement of electricity it is obviously necessary to employ instruments which shall give direct indications. The relations between the volt, the ohm, and the ampere being fixed and immutable, it is plain that, any two of the three values being known, the other can be determined. If of any circuit in which a current is glowing we know the resistance (in ohms) and the pressure at the source of electricity (in volts), we can arrive at the current strength in amperes by dividing the volts by the ohms. Similarly, if we know the resistance and the current strength, we get the pressure by multiplying them together. There is an almost endless variety of laboratory methods for measuring electrical pressure, current strength, and resistance, all employing a galvanometer of some kind and a standard of comparison by which to establish the values of the unknown quantities.

Coming to the commercial measurement of electricity, it is obviously necessary, as has just been said, to provide instruments which shall indicate directly the values required to be known without manipulation or recourse to standards of comparison. In a central-station those in charge must be able to know at any time what is the pressure on the circuits and how much current is being consumed by the lamps or motors. In most systems of distribution an unchanging pressure is maintained and the current varies according to the number of lamps or motors that are connected to the circuit. In other systems exactly the reverse takes place, the current being the constant element and the pressure the variable one. The power drawn from the station is in any case equal to the product of the two factors, and it varies continually as consumers turn their lamps and motors on and off. Consequently, in order to know what their machinery is doing, the attendants at the central-station must have direct reading volt-meters and ampere-meters, which will indicate

at any moment the pressure on the circuits and the amount of current flowing into them.

At the consumer's house or office a meter is required which will indicate the amount of electrical power supplied to his lamps or motors during any given period of time. This meter, unlike the central-station measuring instruments, which can be arranged so as to be switched in and out of circuit at will, must be connected permanently in the circuit so that it will record continuously the power that is supplied to the group of lamps under its surveillance. These electric meters, when designed for use on circuits where the pressure is kept constant, as for instance in the low-tension system of electric-lighting, simply register the amount of current consumed by the lamps; the pressure being known, the amount of power consumed is readily arrived at. If on a 110-volt circuit a consumer has used 2000 amperes of current in a month, the amount of power used is 220,000 watts, or 220 kilowatts.

In the design of direct reading or recording electrical measuring instruments the various effects of the electric current have been utilized in many different manners. The larger proportion of commercial measuring instruments, however, depend on electro-magnetic mechanism for their action; that is, on the effect of the current on a coil placed within the influence of a permanent magnet, or vice versa. In other words, the family of electro-magnetic voltmeters and ammeters are descendants of the galvanometer previously described. The construction of these instruments is comparatively complicated and involves a high degree of mechanical and electrical knowledge and skill and the most scrupulous use of the best material obtainable. Every instrument turned out is most carefully tested and calibrated by standards kept in the laboratory, and their readings, which are given by a pointer moving over a dial or curved scale, are generally accurate to within a fraction of 1 per cent. In recording instruments the current sets in motion a miniature electric motor, which communicates its movements through a train of wheels to a set of pointers arranged over dials, similar to those of a gas-meter, corresponding to units, tens, hundreds, thousands, and tens of thousands. The speed of the motor varies with the power passing through it, and consequently the pointers on the dials move slowly or fast according as the power consumed is small or great. The figures on the dials represent watts, and if the charge is so much per kilowatt the consumer can ascertain at any time the amount of his indebtedness to the company.

A very ingenious form of meter is that used by the Edison companies. It is an electrolytic meter and consists of two plates of zinc suspended in a jar containing zinc solution. The current, passing from one plate to the other, dissolves zinc from the first plate and deposits it on the second. A current of any given strength will deposit exactly so much zinc in a given time. The weight of the plates being accurately determined before the meter is put in use, the difference in their weight at the end of any period of time will indicate how much current has passed through the meter. The meter is so connected that exactly one-thousandth part of the current used by the consumer passes through it. The meters are removed periodically and the plate which has suffered loss of metal is carefully washed and dried and then weighed in a chemical balance. The difference between the original weight and the weight found shows the amount of metal deposited on the other plate. The reason for weighing the plate which has been dissolved rather than that on which metal is deposited is that greater accuracy is secured, as a certain amount of zinc always remains in the solution. The difference of weight in grains shows the number of amperes used by the consumer.

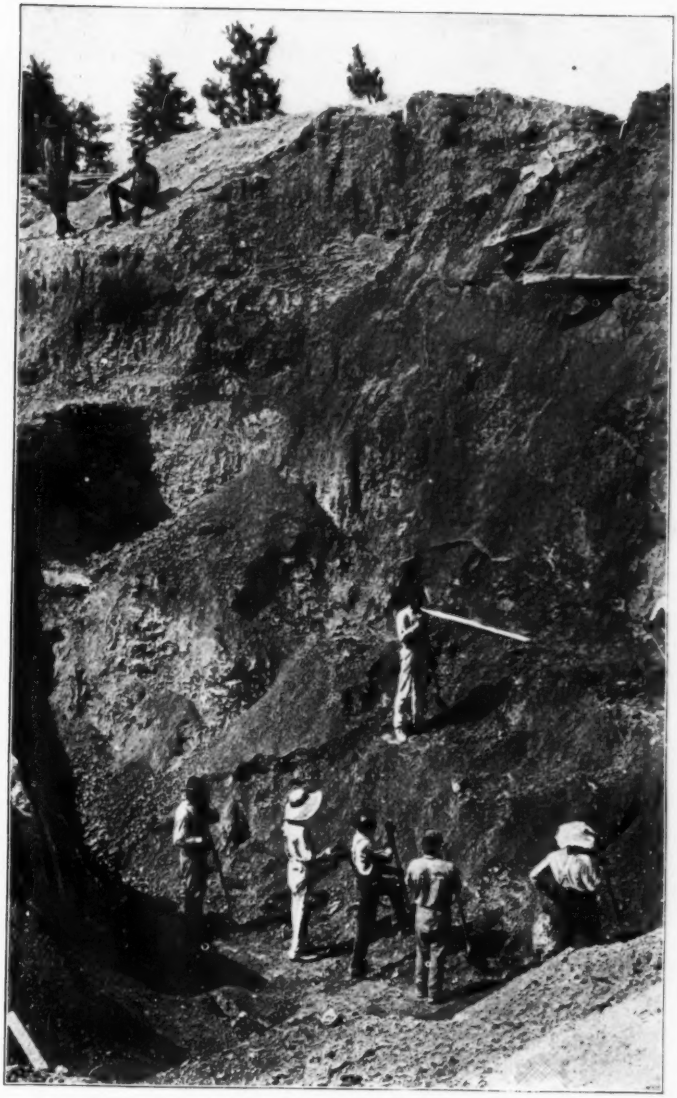
THE PHOSPHATE INDUSTRY OF FLORIDA.

By Floyd B. Wilson.

THE phosphate industry has brought new life and possibilities to certain sections of the South. It has made financial successes of railways that were languishing, and given lands a value beyond the wildest dreams of the owners. Yet the real value of the discovery of these vast mineral deposits to the country at large has hardly been comprehended. It is not a discovery affecting a few localities; it is one of great importance to the whole nation.

Phosphate is the germ of plant life, and overworked and unproductive soils, by its introduction, can again be made capable of producing their wonted harvests. The expense to the farmer of the cost of a fertilizer may be a question of no trifling importance; but a far more serious one is that of the possibility of his not being able to find a fertilizer at all. In this country, particularly in the West, where the virgin soil was found to possess a depth and richness apparently limitless, no care was made to guard against its impoverishment. The stored-up richness of the soil met, for many years, all the exactions of the farmer. But gradually the harvest from the same acreage grew less and less. From sixty bushels of wheat per acre, the crop fell off until twenty were considered a fair yield. It was not difficult to learn the cause. The land had lost something that plant-life required. Could it be restored? The agricultural chemist soon was able to give an affirmative answer to this question; but the average farmer has been slow in following the advice of the chemist. All plant-life must be fed, and phosphates alone can sustain it. Given the soil and its average product, the agricultural chemist can tell almost to a fraction the component parts needed to make up the fertilizer required to double the harvest, and phosphates form from 60 to 80 per cent. of the constituents to be used in every case.

The value of phosphates on the farming and vineyard lands in Europe has been known for centuries. When the phosphate beds of the continent of Europe failed to furnish enough to meet the demand, requisitions were made upon the phosphate deposits of South Carolina to supply the deficiency. Later the Canadian phos-



A DEPOSIT OF HARD-ROCK PHOSPHATE.

phate, commonly called "apatite," helped to supply the demand from Europe.

For many years the South obtained its phosphate for the cotton-producing lands from the South Carolina beds, and this demand, coupled with the European requirements, made this industry an important factor in the commerce of Charleston. The "apatite" of Canada was first received in Europe with great favor, because of its high percentage in phosphoric acid; but on account of the expense attending its mining and conveyance to market, it is not now so extensively sought for. There is a limit, of course, to all these deposits; but, although many have been worked out in South Carolina, the supply from that section is very far from exhausted. The phosphate of South Carolina, however, is of low grade; and the commercial questions to be considered are, first, the cost to mine, prepare for market, and deliver at port, and second, the percentage of the product in the equivalent of bone phosphate of lime. The Florida phosphate was received with favor abroad upon its introduction into that market, owing to its very high grade.

The Peace river pebble was the first of the Florida phosphate rocks that became a commercial factor in the Bulletin quotations of Liverpool. This pebble gives an average of about 60 per cent., and the ready market which it found in the various fertilizing establishments throughout the world caused experts to prospect in every direction over the peninsula of Florida. The area of the beds of

SCENERY NEAR FLORIDA PHOSPHATE BEDS.

PHOSPHATE PITS, SHOWING USE FOR WHEELBARROWS.

TRAMWAY THROUGH A FLORIDA PHOSPHATE BED.

phosphate in that State, so far as discoveries have been made, extends substantially from Hamilton county on the north to Galoosahachee river, in Lee county, on the south, and from the Gulf of Mexico eastward for twenty to fifty miles. It must not be presumed, however, that this mineral is found in an unbroken mass over this immense area. The beds are often interrupted for miles, showing a later geological formation, or that the conditions were not favorable for its accumulation.

The beds of phosphate in this peninsula may be classified as four: the Peace river pebble, land pebble, hard rock, and mixed land pebble and plate rock. The Peace river deposit occurs in a semi-fluid state, so that it is raised by means of pumping and almost wholly without the employment of manual labor. The product so obtained is then dried, when it is ready for shipment. The discovery of this deposit was made in the summer of 1889, and during the following winter the industry became so flourishing that a line of ocean steamers was established between Charlotte Harbor and Baltimore. For a time the supply seemed to be inexhaustible,—the semi-liquid fertilizer even flowing toward the pumps and in undiminished volume. With the later discoveries of a higher-grade rock, however, the shipments from this section have decreased, some phosphate experts claiming that these beds are substantially worked out.

The land pebble is especially prominent in Bartow and Polk

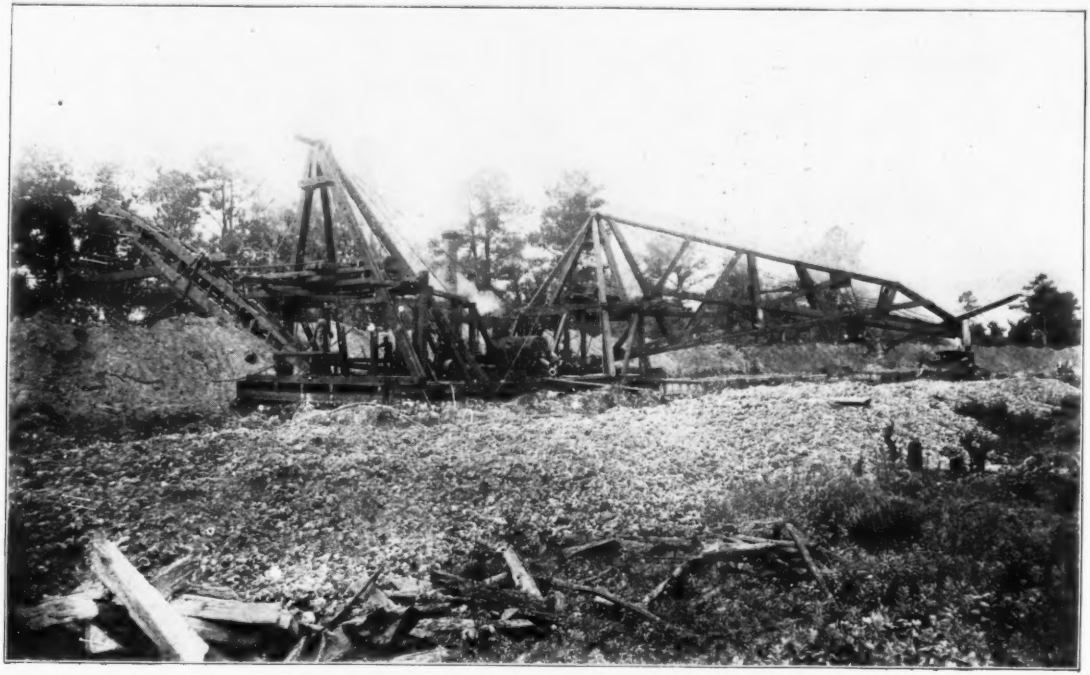
PLANT OF THE STRANAHAN COMPANY, SHOWING TROLLEY CONVEYOR.

counties ; and, although some of the rock is of very high grade, no considerable shipments from these deposits have yet been made. This land pebble seems to be imbedded in clay, which is not readily washed from the mineral. The Phosphoria, an English company, has commenced the mining of this rock, and is doubtless the pioneer in successfully preparing the land pebble for market.

The hard rock phosphate was, I believe, first discovered by Albert Vogt, of Dunnellen, near the junction of the Withlacoochee and Blue rivers, in Marion county. Mr. Vogt picked up some chalky specimens, thinking that they might be gypsum, and handed them to Mr. J. F. Dunn, who in turn sent them to Dr. Rene Snow-

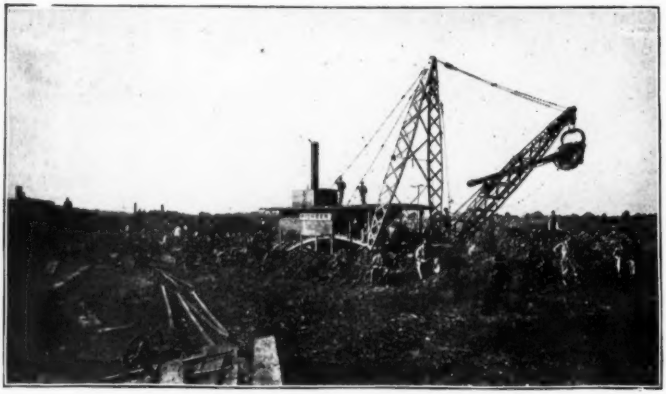
A DREDGE AT WORK LOADING A TRAIN.

den, a chemist of Ocala, for examination. Analyses showed these specimens to run from 60 to 81 per cent. in the equivalent of bone phosphate of lime, and the excitement which immediately followed could hardly have been greater had the mineral discovered been gold instead of phosphate. This phosphate is found in pockets, the beds usually having an overburden of from ten to fifteen feet, which must be removed to get at the rock. The pockets are of varying sizes,—some of them being thirty feet deep and covering a large area, while others are so small as hardly to pay for working. At first it was supposed that the rock required no treatment, and that it was simply to be quarried out and shipped to market. Experience, however, soon taught that the deposit was not free from



A DOUBLE-END TRACTION DREDGE AT WORK ON LAND.

moisture and from foreign substances, and that formidable works were needed to make the product desirable. For a time—and it is the case still to some extent—the rock was quarried and laid on vast kilns kept burning by the pine wood cut from the surrounding forests. Next it was crushed, and then put through separators, when the mineral was ready to ship to any of the markets of the world. The most satisfactory method of treating this hard rock now seems to be first to crush and then wash it, while the drying, instead of beginning, completes the process. Among the companies in this district is the Dunnellen, which has a large plant, capable of preparing fifteen hundred tons per week, and credit is especially due this company for the almost world-wide reputation



DREDGE AT WORK IN A PHOSPHATE MINE.

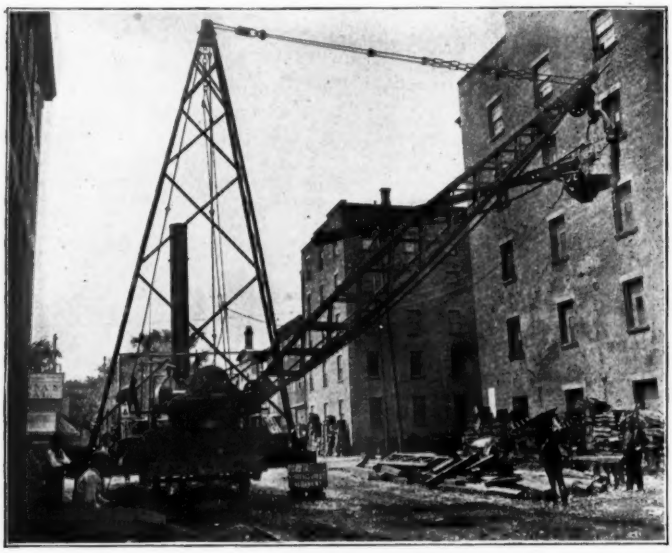
attained by the hard-rock phosphate of Florida. The Eagle Company has recently commenced shipping, and is now one of the large producers of the district.

The mixed land pebble and plate rock is peculiar to the Anthony district, in Marion county, is of exceptionally high grade, and is more easily and cheaply prepared for market than any other class of phosphate. This entire district embraces an area of about two and a half by one and a half miles, and, although this territory is not all phosphate land, yet wherever the phosphate is found it is in continuous beds, often embracing many acres in extent. The phosphate here rests upon "water-worn limestone, which lies in an irregularly shaped mass, presenting a jagged surface rising in pyramidal knobs and showing numerous pot-holes," which often

A PUMP DREDGE.

extend to a depth of forty feet. These cavities or pot-holes are filled with the mineral. It is in the form of small pebbles and broken plate, and it is shoveled into the cars, no blasting being required. The sand covering, or over burden, is very light, varying from only a few inches to three feet in depth.

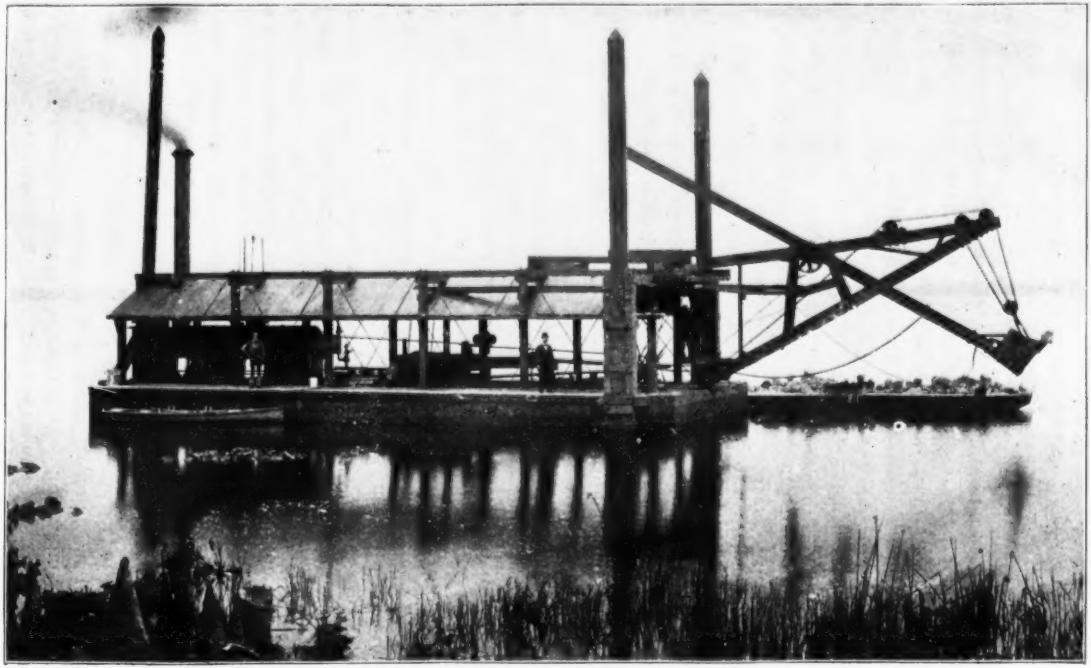
Geologists tell us that the limestone on which the phosphate rests belongs to the eocene period of the tertiary formation, and that it has never been submerged since it was elevated above the level of the sea. The phosphate of this district is guaranteed by



A PHOSPHATE DREDGE BEFORE SHIPMENT FROM THE FACTORY.

the several companies producing it to be 75 per cent. rock, while its average is from 77 to 79.

The plant for treating the mineral of this district is very simple. The rock is mixed with clay and sand, and is first received in washers consisting of eighteen foot wire-gauge cylinders three feet in diameter. The sand and clay are washed out by the revolving motion while the rock is carried forward to an elevator or shaking device which frees it, to some extent, from the moisture left after washing, and drops it in the dryer, from which it is automatically elevated to the warehouse. The stuff is, therefore, shoveled into the



DREDGING FOR PHOSPHATE IN LAKE HANCOCK, NEAR BARTOW, FLORIDA.

cars, which are dumped at the washing hopper, and then it passes on without any handling until it starts as a clean product on its way to market. The Anthony district is very limited in extent; and this fact, together with the low cost of preparing the rock for shipment, its very high grade, and proximity to the port of Fernandina via the Florida Central and Peninsular Railway passing across these beds, account for the purchase of all this territory within a very short time after its discovery. Some ten or eleven companies are in possession of the whole of the property of this district. Several of these are erecting small plants capable of handling twenty to forty tons daily, while controlling an area of barely forty acres. One company owning but fifteen acres has a small plant to which is added a pulverizer whereby it produces a fertilizer, and carries on a sort of retail business with the consumer.

A French company, composed of capitalists in Paris, has made large purchases of lands in this district, and works are now being erected which will soon enable it to commence extensive shipments of phosphate to France. The Stranahan company was one of the first established here, and it made some very expensive experiments before the plant requisite to treat this phosphate was determined upon. One of the late comers in this field was the Central Florida Phosphate Company, whose extensive works, on a leasehold of two hundred and fifty acres, are now nearing completion.

Professor E. T. Cox, one of our oldest geologists, who was for twelve years State Geologist of Indiana, has made the phosphate beds of Florida a special study, and before the Committee on Rivers and Harbors of the National House of Representatives last winter, he declared these to be the most extensive known to the world. Following this, he said: "The discovery of these beds of phosphate of lime is only second in importance to the discovery of the precious metals in California and the Rocky Mountain States and Territories. I think it safe to state that the companies around Anthony will soon be able to load a vessel every week. At first it might be supposed that phosphate-mining would be soon overdone and rendered unremunerative, but it must be borne in mind that this is the most important mineral food for plants. Phosphate of lime represents about 80 per cent. of the ash of plants, and where it is absent in the soil no grain can mature. If we even take in the waste on worn-out fields, thickly dotted over the States from the Gulf of Mexico to the British Possessions on the North, it will be apparent that to supply the exhausted phosphates

and render these fields once more productive will require a large consumption of phosphate of lime. In California, when they commenced to grow wheat, it was not an uncommon thing to raise from seventy to ninety bushels to the acre; now the yield will hardly average twenty bushels. The falling-off is due to the exhaustion of the mineral plant-food. There is no way to restore these lands to their primitive fertility except by a direct application of the mineral constituents that have been removed by the crops, the principal of which is phosphate of lime."

For the past ten years the foreign demand for phosphate has increased about 10 per cent., from year to year, until now it amounts to about 175,000 tons per annum. Europe uses annually an average of one million tons, so that Florida is now supplying nearly 18 per cent. of her total consumption. The high grade of Florida phosphate is rapidly bringing it into great favor with the manufacturers of fertilizers in France, Germany, and Holland, and the demand for these countries promises to increase to the detriment of the market for the lower grades produced at home.

In 1891 thirty-five vessels loaded with phosphate cleared from the port of Fernandina for divers European ports, and the present year will show a large increase in shipments. From the records of the Secretary of State of Florida it was shown, in a report made in December last, that independent of the Peace river district there were $36,960,000 invested in phosphate companies within the State. Last winter the Governor of Florida appointed a Commissioner to represent the minerals of the State at the Columbian World's Exhibition, and this commissioner stated to me that the only other Florida mineral was a clay used in the porcelain and China arts.

For a long time the State of Florida has been renowned as a winter resort for those seeking a mild and healthful climate and as a source of early vegetables for the spring market in the North, and tropical fruits throughout the year. The stream of passengers north and south, together with the shipments of garden produce and fruits, did little more than make the railroad lines self-sustaining. The phosphate mineral industry now comes forward to lift the State into commercial prominence, and give it a commerce worthy of the name. Here we see conditions directly the reverse of those of California. There the discovery of the precious metals awoke a dreary waste to activity, while agriculture later gave the State its greatest prominence in the Union.

The port of Fernandina will grow in importance to meet the demands of the new industry. In a report made by General Gilmore, in an official letter dated November 7, 1885, he says: "It is the only harbor south of Charleston the entrance to which is capable of being improved to a low-water depth of twenty-five or thirty feet at a cost equally moderate. The harbor of Cumberland Sound has great national importance in its relation to the defensive and naval policy of the country, and has all the elements essential to usefulness as a harbor of rendezvous, outfit, and refuge." With deeper water at Fernandina, larger vessels running at regular intervals will carry this phosphate to all parts of the world, better rates will be obtained, and Florida's great industry will grow in importance to the benefit of the State, the nation, and the agricultural interests of the whole world.

INTERIOR FIREPROOF CONSTRUCTION.

By John M. Carrère.

IN the May number of THE ENGINEERING MAGAZINE, Mr. Edward Atkinson states that for tall office buildings built of steel and veneered with incombustible materials: "It is very plain that if the inside finish of such buildings is also of incombustible material, including floors, moldings, and every other element, then the internal hazard will consist only in the possible combustion of office furniture, books, papers, and like contents."

In other words, even if absolutely no combustible material is used in the internal construction of a building, there is always the furniture and other property belonging to the tenants, stored therein, which will burn. This element is one that cannot be avoided. The natural conclusion is, therefore, that as the possibility of a fire will always exist, this fire, when it occurs, should be confined to that portion of the building, or if possible, to the individual rooms in which it originates.

Mr. Atkinson suggests one remedy,—namely, the use of absolutely incombustible materials for the interior finish of fireproof buildings. This certainly would add greatly to the fireproof properties of such a building, but it would only be a partial and not the best remedy.

While there are a great variety of excellent materials for fireproofing the *constructional* portions of the building, such as are used for covering iron-work, building floors, etc.,—most of which have been tested, giving us actual data to act upon in our selection,—no means have yet been devised, or at least no means that would be acceptable to the investor, to the tenant, or to the architect, of finishing a building with non-combustible material.

It would be rather difficult, for instance, to substitute anything but wood for the finished floors, for the sashes and doors, and for a great portion of the trim. The fireproof materials now in the market for this purpose fail to meet the requirements because they are not entirely satisfactory as non-combustible materials,—being really not fireproof but slow-burning,—as for instance, woods treated and made slow-burning, all sorts of fibrous products, and other compositions. Another objection is that some are so expensive that it

would be out of the question to attempt their use, unless compelled by statute to do so,—as for instance, stones, marbles, terra-cotta, or metal. Or, if they meet both of the above objections, the materials are usually unsightly or not serviceable, as plaster and certain kinds of cement.

The writer believes that stamped metal filled with plaster of Paris, or some other such material, might be used for a good deal of the trim and for the doors, in a very satisfactory manner, and if designed to express the material, could be made pleasing in effect. But it is questionable whether, even if such an article were on the market, it would be acceptable in the place of the present method.

It seems that at the present time, therefore, the best that can be done is to reduce the amount of such work to the minimum, and to construct it in such manner as to allow of no voids behind it. Neither can any practical improvement be made in the manner of finishing this work which would render it incombustible. As long as woodwork is used, it will have to be either painted or varnished, and no fireproof paint or varnish can be considered more than a partial remedy.

As far as the floors are concerned, in a number of cases in New York city and elsewhere, they have been finished with cement, granolithic, or some other similar material. But with all the advantages of this system, it makes a cold, hard, disagreeable floor, very expensive in itself, and increasing the cost of the construction by its weight ; and with the present method of distributing the mechanical plant—heat, light, plumbing, etc.—it is found very inconvenient, especially in such structures as office buildings, where constant changes are necessary.

From the above arguments it would seem as if the case were a hopeless one. In addition to the fact that the furniture and other materials stored in the building are combustible, it seems a practical impossibility to avoid using materials of a combustible nature for a great proportion of the interior finish of most fireproof buildings. It remains, therefore, to be seen in what way the fire can be *confined.*

The floors, if properly constructed and made fireproof, will prevent the fire from extending directly from one story to another. The chances of the fire spreading laterally through a building will be greatly lessened if the partitions are properly constructed and made fireproof,—no partitions made of wood being used (their cost being more than twice the cost of fireproof partitions) ; all partitions

being built solid and without the usual sashes and transoms, and the halls being planned to obtain light from windows in the outside walls at the ends of the halls when possible. If the hall doors and jambs are made of fireproof materials, the chances will be still lessened, and if the connecting doors and jambs are also made of fireproof materials, then each room can be considered so isolated that a fire would either smolder or burn out within the room in which it originates. The use of the modern patent wall plasters, several excellent brands of which are on the market, has been known to retard the spread of flames and in several instances to prevent fires. The testimony to this effect is conclusive.

The writer believes, therefore, that the principal danger that could in a great measure be met fairly and squarely and avoided is due mostly to the improper use of materials, resulting from the lack of proper judgment in providing for the *mechanical features* of the building, and to a great extent in *planning* the building.

It is a general rule for the architect and engineer to work independently of each other, and for the architect to depend, after the building is erected, on the ingenuity of the expert for the installation of the mechanical plant. This results in work which is not only complicated and expensive, but absolutely inefficient, especially from the standpoint of fireproof construction.

It is the opinion of the writer that the proper installation and distribution of the mechanical features of every building should enter into the original scheme. For, when the architect can and will prepare for the expert, it becomes then an easy matter for him to make his installation in such a manner as to obtain, constructively, a building virtually fireproof.

The method now in use, to which most of the evil is really attributable, consists in providing chases any and everywhere, in the outer walls, or through the center of the building; very frequently these chases, proving inadequate, are added to, or, not proving to be in the right place, are changed or replaced by other interior chases, and in these all of the vertical lines of supply of what the writer terms the *mechanical plant*—namely, plumbing, heating, lighting, ventilating, etc.—are carried through the building, forming just so many channels of connection for fire, from cellar to roof.

In a large percentage of the buildings these chases are merely enclosed, either totally or in part, with wooden coverings; they are therefore not fireproof even in their outer construction, and it is

very seldom that they are partitioned off horizontally at each floor to intercept fire. Other combustible construction, such as floors, grounds, furring, etc., are allowed to run across these chases and into them, adding to the fire risk. Such is the *usual vertical installation of the mechanical plant.*

The *horizontal installation* is then provided for by wooden sleepers, virtually floor beams, placed on top of the iron beams, usually four inches high. The purpose is to obtain a nailing for the finished floors, and sufficient space above the iron beams to include all of the mechanical plant. The spaces between all of this wooden construction are then filled in with some kind of light concrete made of ashes, or stone and cement, or plaster of Paris. We have, therefore, on the top of every floor about half as much combustible material as would probably be used if we had no iron floors under them at all, and the danger would be very great without the filling in. But it is customary in building, for the sake of obtaining a rough floor to work upon, to fill in the moment that the sleepers are fastened to the beams, and to lay the rough floor before any of the mechanical plant is in position.

The result is that the filling is faithfully dug out to admit of placing all of these pipes, etc., in position, and it is the experience of the writer that fully 25 per cent. of the filling is destroyed, and even with the greatest care and constant superintendence it is impossible to have all of it replaced. The rough floors are simply lifted, the filling dug out, the pipes placed in position, and, before the architect or superintendent has the opportunity to see the work done, the floors are put back, often leaving a void, out of sight and out of mind.

Such is therefore the *usual installation of the horizontal portion of the mechanical plant.* But the evil does not cease there. After the building is completed, and as the offices are rented, and later as vacancies occur and other changes are made, there is a constant ripping up of the floors, redistributing of the mechanical plant, and destroying of the fireproof properties—such as may still exist—of the floors.

If, when a building is first planned, it is so arranged that the ceilings of the halls can be dropped, thereby obtaining a horizontal space between the floors and ceilings of the halls on every floor, which can be lined and made entirely fireproof, all of the horizontal portion of the mechanical plant excepting the steam-heating can be placed in these ducts.

This process is economical both as to construction and as to installation, and every particle of the horizontal plant is then always within reach for repairs or changes, and is placed in the most favorable position for immediate connection with the rear end of all the offices, where all the plumbing fixtures, etc., should be located, instead of occupying the most valuable and well-lighted space—as is so often the case—in the front end of the offices.

By also planning in this duct a system of air-ducts, office buildings can be economically and efficiently ventilated, either by exhaust or by indriven air, at virtually little expense. But in addition to all of these advantages, a plant thus arranged would be virtually permanent, for, no matter what changes occur in the redistribution of offices, nothing would ever have to be removed, excepting the fixtures above the floor or below the ceiling, still leaving all of the main lines and their feeders untouched.

At the ends of these horizontal ducts, vertical chases or ducts, solidly built of fireproof material,—hollow blocks or brick,—can then be provided, running from cellar to roof, furnishing the best means of installation for the vertical plant, and connected at each floor with the horizontal ducts. For a further safeguard, it becomes an easy matter, under these circumstances, to partition off the vertical chases at each floor, and the horizontal chases as often as needed, with wire lath and plaster of Paris, which can easily be removed and replaced as occasion demands with plaster boards, mineral wool, or some other equally convenient and safe material. It will be seen that by this arrangement there are *absolutely no vertical chases in the center of the building.*

The only portion of the mechanical plant which has not yet been provided for, the steam heat, can be arranged by placing vertical chases in the outside walls. If the steel-frame construction is used, the columns can first be fireproofed, then a chase made around this fireproofing, and a second fireproof wall built around it, doubly fireproofing the column by the intermediate space or chase.

In this chase vertical risers can be run from top to bottom, entirely enclosed,—avoiding the objection of radiation in offices where steam is not wanted,—and these pipes can then be tapped at every floor with horizontal branches, run above the floor and directly to the radiators, which are then placed opposite to and under the windows, as they should be, admitting of direct indirect radiation. By this system no steam pipes are placed under or in

LEGEND:

Plumbing: ——— or "S" indicates Soil and Waste pipes.
- - - - - - - " "B.A." " Back Air Vent pipes.
"W" " Safe Waste pipes.
"P" " Water pipes.

Electricity indicated by ——·——·——
"B" indicates Cut Out Boxes.
"C" " Conduits for Electric light, Telephone, Ticker and Messenger wires.
"E" " Electric Light outlets.
"E-G" " Combination Electric and Gas outlets.
"Sw" " Switch controlling Combination chandelier.
"T.M" " Outlets for Ticker, Telephone and Messenger wires.

Heating: ——— " Steam pipes.
═══ " Radiator.

Ventilation indicated by ——···——···——
"D" indicates Branch ducts.
⊠ " Register in floor.
"V" " " " ceiling.

Gas Main indicated by "G"

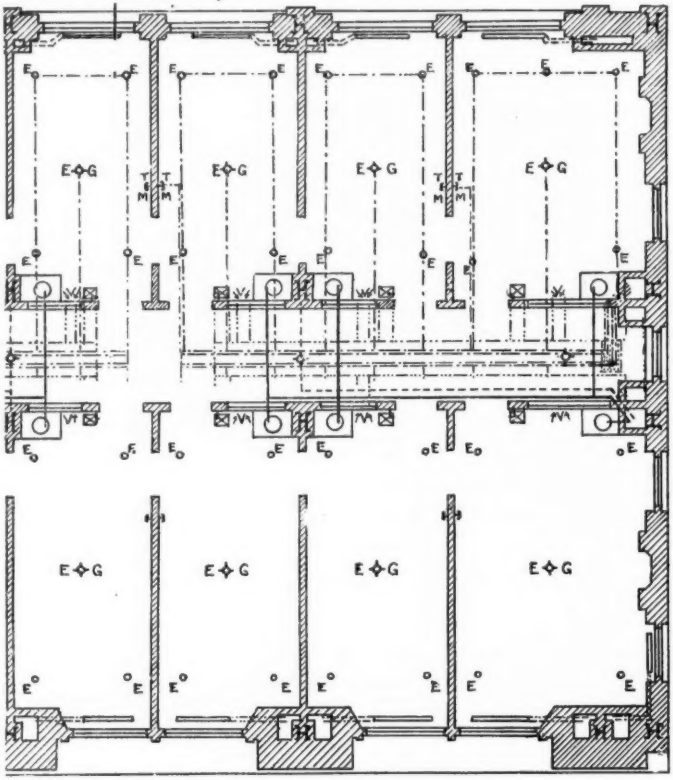


FIG. 1—LAYOUT OF MECHANICAL PLANT.

[Competition for Manhattan Life Insurance Company's Building, New York.]

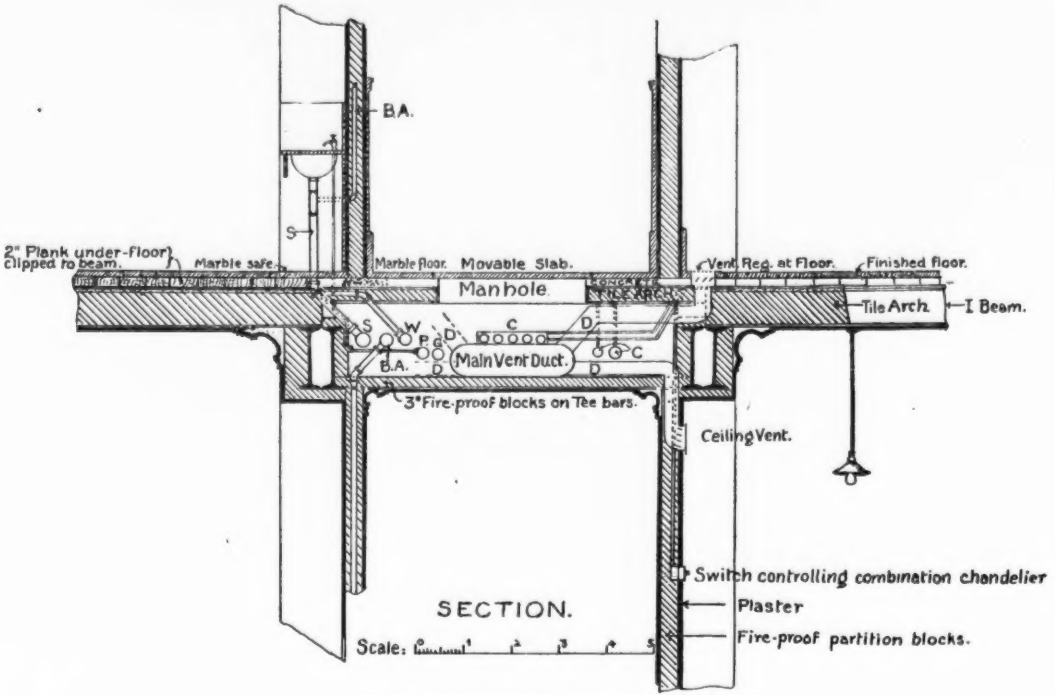


FIG. 2—SECTION FROM PRECEDING PLAN.

the floors, where the heat is apt to injure the floors, and also to expand the iron-work in them. The entire steam-heating plant is easily reached ; repairs, changes, additions, etc., are made without injury to any part of the building ; and as the offices are determined by the windows,—these being necessarily in the outside walls,—each and every office can be always heated, no matter how the partitions are changed.

In addition to the efficiency and economy of a mechanical plant installed on this plan, the writer believes that the highest grade of fireproof construction could be obtained, and that the great advantage would then exist of a plant which, once installed, would virtually remain undisturbed.

The illustrations accompanying this article [Figures 1, 2, 3, and 4] show the usual way of building floors and of providing for this plant, and also the way suggested by the writer. From the economical standpoint the illustrations show that with this system, no matter what size of floor beams is used, the thickness of each floor decreases at least four inches by the omission of the sleepers usually placed on the iron beams, and if wire lath is used for protecting the lower flange of floor beams instead of using flat arches with flange protectors, two inches more are gained. Six inches can therefore be added to the height of each floor without adding to the total height or total cost of the building ; or the total height of the building can be reduced by as many times six inches as the number of stories without reducing the number of stories, making for a twenty-story building a reduction of ten feet, or the equivalent in height and cost of one full story. In other words, a building intended to be twenty stories high could be made twenty-one stories high without increasing the original cost of the construction, except by the additional strength required to carry the additional weight of the twenty-first story.

The wire or metal-lath flange protection suggested above will hold the plaster better than any other material now used. The floor arches of the full height of the beam are also not only cheaper in original cost than concrete, but they are also lighter in weight, decreasing too the weight and cost of the iron, and, last but not least, when once in place they are permanent and cannot be dug out or otherwise disturbed. [See Figure 3.]

As stated above, this system involves *studying the plant as a part of the original scheme*, and it involves *planning the building constructively and otherwise to meet these requirements.*

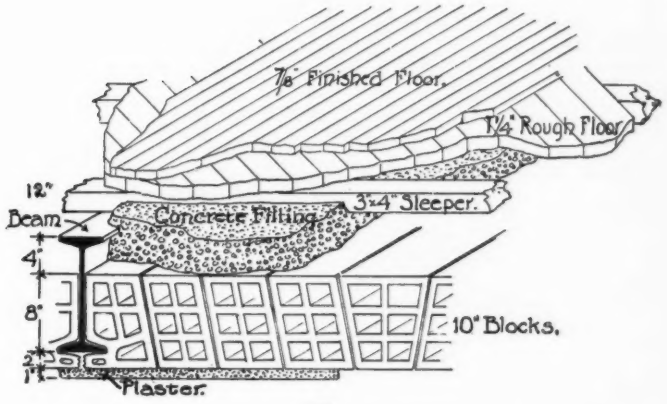


FIG. 3.

In addition to this problem, the writer believes that, if a building is so arranged, whenever possible, as to be divided into several sections, separated by intervening courts and connected by entirely fireproof passages, in which the staircases and elevators can be placed, a further and very efficient check will have been provided against the spreading of the fire laterally.

Two fires which occurred quite recently in the "Edison Building," in New York, have led to the writing of this article. In both cases the interior finish of the portion of the building where the fire occurred was of a highly combustible character, the partitions

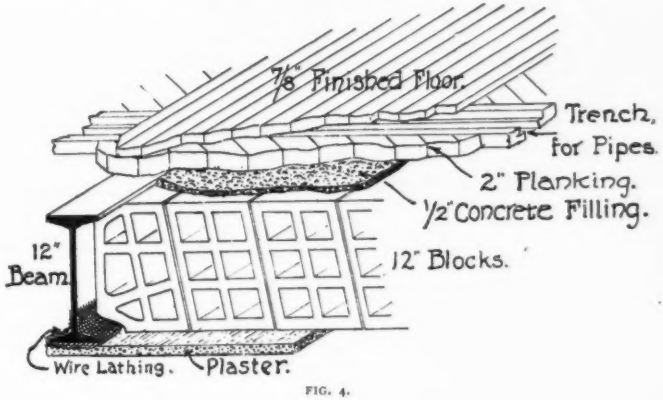


FIG. 4.

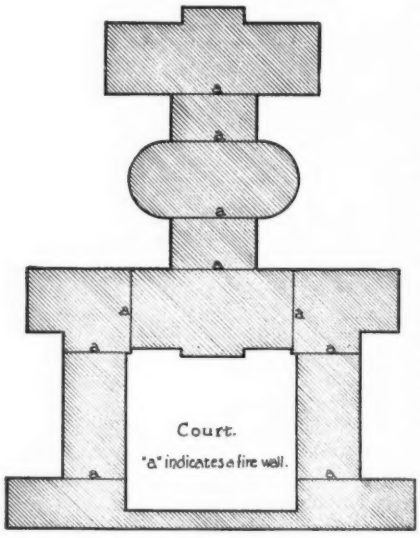


FIG. 5.

being mostly of wood with cabinet finish and plate-glass sash, the rooms being divided into very small spaces and crowded with furniture and papers. The writer believes, in view of the fact that the construction of this building is similar to the usual process of fireproofing, —except, however, that most of the mechanical plant was installed before any filling was done, and that the inspection of this filling was made a special object before the floors were laid,— that the fact that the fire did not spread beyond the portion of the building where it originated is in a great measure due to the plan of the building, which divides it into two distinct portions connected by links as above suggested. The diagrams given herewith show plans of several buildings arranged in this manner. [Figures 5 to 11.]

As an illustration of what can be done in the planning of a building or portions thereof to prevent or check a fire, the writer submits a series of small plans [Figures 12 and 13] showing what in his mind would be an absolutely fireproof staircase, arranged for one, two, or more elevators, and adaptable to all buildings, especially hotels, theaters, and other buildings which are not otherwise fireproof. The plans show an arrangement

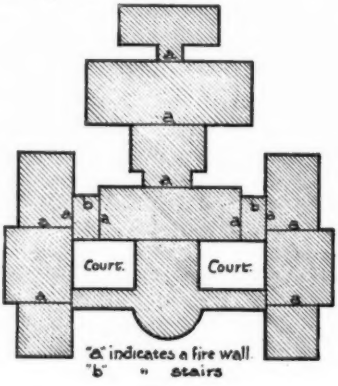


FIG. 6.

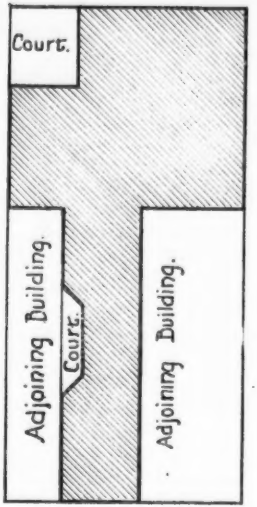
HOME LIFE INS. CO.
Competition.
247 Broadway.

FIG. 7.

"LIFE" BUILDING.

21 West 31st St.

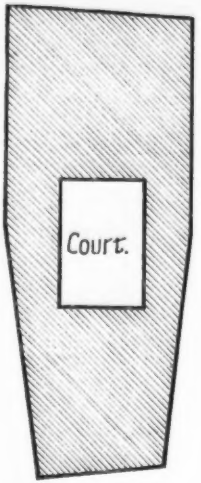
FIG. 8.



"MAIL AND EXPRESS" BUILDING.

203 Broadway.

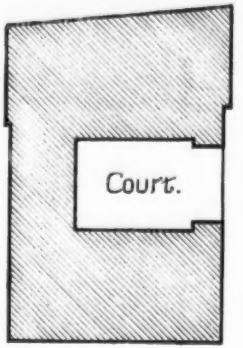
FIG. 9.



EDISON ELECTRIC CO. BUILDING.

44 Broad St.

FIG. 10.



MANHATTAN LIFE INS. CO. BUILDING.
Competition.
72 Broadway.

FIG. 11.

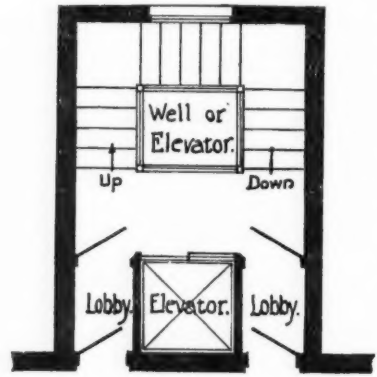


FIG. 12.

which is absolutely the reverse of what is usual, and for that reason is not easy to introduce into practice.

The writer does not wish to be understood as laying on the architect all the blame for the defects above suggested in the construction, planning, and installation of fireproof buildings.

The architect is expected to know so many things; so much responsibility is thrust upon him; he has to work with so many limitations as to existing laws, existing customs, and requirements, in addition to the further limitations forced upon him by his client,—that it is a wonder that he has been able to accomplish the many things that we notice and admire. It is easier for almost any one than it is for the architect to convince his client, or the public generally, that *what is usual is not necessarily the best thing*.

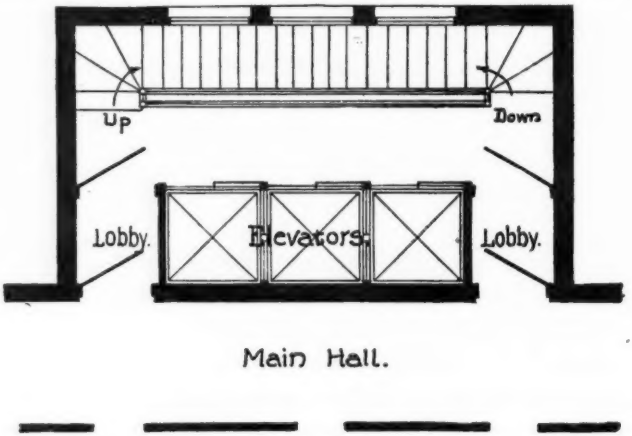
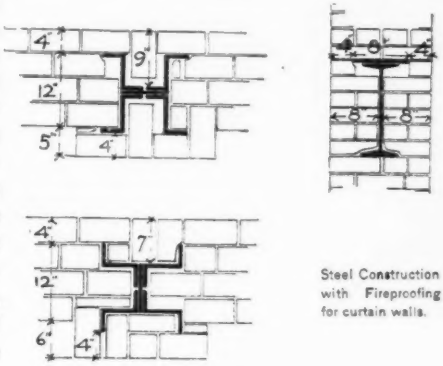


FIG. 13.

What chance of success would an architect have if he were to argue with his client against the use of steel-frame construction, or against the advisability of erecting tall buildings, when the building-laws of New York city, for example, not only sanction but fully provide the conditions under which such buildings can be erected, establishing the thickness of the walls in such a manner that the very dangers from outside causes which Mr. Goetz and Mr. Atkinson both refer to in their articles in this magazine cannot fail to exist? If steel construction is used, the walls must be made thinner, for the saving of space is the principal object in view. These walls have to be carried, as they are not self-supporting They should for this reason also be made thinner, so as to decrease the weight to be carried. The columns that carry such heavy weights as these walls, no matter how thin the walls are built, cannot be safely loaded on the eccentric; the columns have therefore to be moved to the center of the wall or as near thereto as possible. The result is unavoidably to reduce the thickness of the outside covering.

The writer believes that with steel channel or Zee bar columns for vertical supports, and I beams or channels with the flanges turned outward, steel plates being placed on them for horizontal supports, thus supporting every part of the masonry directly on the framing, the hazard is very greatly diminished and better and thicker protection can be obtained, with also a thorough and natural bond for the mason work,—as shown in an illustration herewith. [Figure 14.]

There is good reason, at least from the investor's standpoint, for the erection of such buildings. If a building is erected on a lot situated one block from Wall street containing 8000 square feet and costing $1,250,000 (at an average of 47 cents per cubic foot, which is a high figure), it may be estimated, supposing a total rentable area of 5000 square feet (the other 3000 being devo-



Steel Construction with Fireproofing for curtain walls.

FIG. 14.

ted to courts, walls, etc.), and considering the fact that the additional number of square feet obtained on the first floor, where rents are the highest, would pay for the space sacrificed for the cellar, that to obtain a gross income of 10 per cent. it would be necessary to get an average rental of $4.80 per square foot for a ten-story building, $3.36 per square foot for a fifteen-story building, and only $2.80 per square foot for a twenty-story building.

In conclusion, the building-laws have been and may still be altered, but there are so many interests to be considered in doing so, other than those discussed by the writer, that the result has never yet been, and can hardly ever be entirely satisfactory. Other influences can be exerted in the same direction ; architects may use their best efforts to reach satisfactory results, or at least to assist in doing so ; but no interest, as has been often demonstrated, has it so fully in its power to bring about a change in the right direction as the " Insurance interests."

In New York and other cities the fire underwriters have established many rules which the investor, the builder, and the architect must follow if they expect to obtain an insurance on their buildings. Why should these rules not be extended, and become virtually complementary to the building-laws, thus making restrictions which would be enforced and respected, and which would establish, in a measure, a uniform law for the whole United States? It would tend greatly to improve the character of all our buildings, and help to decrease the very great tax now paid in the form of insurance.

RECIPROCITY WITH CANADA.

By Erastus Wiman.

AT the great quinquennial Congress of the Chambers of Commerce of the British Empire, held in London in June last, it was proposed by the advocates of Imperial Federation among the Canadian delegates, that Great Britain should reverse her policy of free trade with all nations, and "by putting a tax upon foreign products, especially food and fiber supplies, stimulate the production of these within her own colonies by admitting their surplus free; the colonies in return agreeing, by equal preferential duties, to admit English manufactures at discriminating rates. The proposition was a very revolutionary one, so much so that the most intelligent speakers regarded it as absolutely fatal to the foreign trade of Great Britain, which amounts to two-thirds of her entire commerce; and though it was prompted in Canada and elsewhere as the outcome of the most vociferous loyalty to the mother country, it was, by a vote of two to one of the delegates, stigmatized as 'Politically dangerous and economically disastrous.'" Mr. Erastus Wiman was among those who offered vigorous and effective opposition to the proposal, and in consequence, after the Congress adjourned, he was invited by the editor of *The Contemporary Review* to state his position in the pages of that magazine. His article appeared in the August number of the *Review*, and it is now reproduced here* as a very striking and valuable contribution to the literature of the important question of reciprocal trade relations between the United States and Canada. It will be found especially interesting, also, as a Canadian-American expression of opinion addressed specially to an English audience.—THE EDITOR.

THE recent assemblage in London of representatives from numerous commercial organizations throughout the British Empire gave an opportunity for the expression of views of great practical value. The exchange of sentiments, especially among the delegates from the colonies, and again between these and the

* Republished through the courtesy of the Leonard Scott Publication Co., New York.

representatives of British interests, was important, because hardly by any other means could it be ascertained whether or not a common ground of action could be secured. The result was to reveal the widest divergence of opinion on questions of trade policy, specially between the two greatest colonies, Australia and Canada, while among the British delegates there was a division of opinion almost as marked. Perfect unanimity was apparent in many details of commercial reform, but so far as indicating the possibility of a closer commercial union between the colonies themselves, and between them and Great Britain, the convention had no practical result. It had one effect, however, and that was to reveal an intense loyalty to the mother-land, which, in view of the enormous areas represented, the widespread and varied interests concerned, and the vast population interested, numbering 350 millions, was a testimony of the highest character to the wisdom and success with which the government of the British Empire is administered.

The importance to civilization that this government should be maintained the world over wherever it now existed appeared more impressive than ever, for upon its maintenance in one quarter of the globe seemed dependent its existence in another. Although there was no common ground discovered for a union of commercial interests, there was an abounding evidence of the closest and most perfect political and moral union of which it is possible to conceive. This was intensely interesting to the students of affairs in North America, where a possible disintegration of the British Empire is not uncommonly accepted as possible, especially in that vast stretch of territory between the Atlantic and Pacific, over which Great Britain still mildly rules. It is needless to say that, of all the delegates present, those from British North America were the most intensely loyal, and that there was the slightest tendency towards a separation in that colony was most truthfully represented to be utterly improbable.

Nevertheless, in the discussion of the relations hereafter to exist between Great Britain and her colonies, there seemed no realizing sense whatever of the tremendous sacrifices which Canada is called upon to make in order to maintain the line of demarcation, which completely cuts her off from the great growth in the other half of the continent. Before the world the comparison is always inevitable between the retardation within the Northern and greater half of the continent, isolated by its British connection, and the progress of the Southern half, freed from that connection, wherein

a material wealth has been created at which all the world wonders. Compelled as Canada is to confine her trade to the products of narrow latitudes everywhere the same, or with Great Britain 3000 miles away, she is growing so slowly as to excite surprise and apprehension ; while within actual sight a commerce exists, the greatest on earth, in which she has neither part nor lot. This commerce breaks like a huge wave along a border line of unparalleled length, and rolls back upon itself, the literal example of which is found in the shipping of the Detroit river, flowing in front of a small portion of Canada, bearing upon its bosom a tonnage exceeding that of London and Liverpool combined, in which Canada has hardly a dollar's interest.

The material advantage to Canada from an obliteration of the barrier between herself and the nation of forty nations directly alongside, and the resulting development which within her borders would equal that which has already taken place within the Southern half of the continent, is the measure of the sacrifice that Canada makes to maintain her connection with Great Britain. It is fair to say that up to this time these sacrifices have been cheerfully borne on one side, and equally on the other, for with the utmost liberality on the part of the Imperial Government Canada has been left to work out her own destiny.

Yet there was a consciousness sufficiently apparent in the congress that in the continuous struggle between the sentiment of loyalty on the one hand, and material advantage, nature, and geography on the other, the latter might in time prevail. This consciousness found its expression in the effort made to compel the congress to recommend a change in British policy so desperate as to threaten its vast foreign trade, in order that the colonies should have a preference. This recommendation was, however, voted down two to one. Another evidence that the contest in Canada between sentiment and interest has already begun is found in the exodus of her people to the United States. This exodus includes one or more representatives from almost every family in the Dominion, and implies a proportionate personal annexation to the United States of male adults to which there is no parallel, except that which depopulated portions of Ireland in her worst days. Should an equal desire for material advantage be found to exist—and does it not exist?—among farmers, fishermen, lumbermen, miners, and shippers, whose interests are all menaced by continued isolation from the natural market which the United States afford,

it will be admitted that the sentiment of loyalty to Britain will be under a strain too tremendous to contemplate with contentment in view of its possible failure. For the result of that failure would be the loss to Great Britain of her nearest and largest colony, comprising in area no less a proportion than forty per cent. of her empire! Such a loss is viewed with dismay in England, for it might realize the fear expressed by Dalton McCarthy, the wisest of Canadian Tories, that it "would reduce Great Britain to a second-class power," which would initiate a disintegration that would seriously set back civilization.

To obviate such a dire possibility there is, however, one way which the recent congress did not permit to be discussed, and that is to make such a commercial bargain between the United States and Canada as will completely obliterate the barrier between them commercially, leaving both to occupy their present political status. That this can be done with the United States there is no doubt, for it exactly fulfils both the new reciprocity policy of the Republicans, and is in exact accord with the free trade doctrines of the Democrats. When Canada is ready to accept an offer of a market with sixty-five millions in exchange for a market of five millions, a business arrangement can be made between the two countries that will completely prevent a desire for a change in her political condition, because there is no argument on behalf of that change except the commercial or material advantage to be gained. When all the material advantages possible to political union are secured by the simpler and earlier commercial union, which is immediately possible, Canada will be secure for all time to Great Britain.

The argument that the allegiance of Canada to Great Britain must be lessened by an intimate commercial relation with the United States finds its complete refutation in the condition that prevailed at the cessation of the reciprocity treaty in natural products between the two countries for ten years up to 1866, on the termination of which Canada was far more loyal under the high degree of prosperity which that treaty rendered possible than she is now with the barrier between the two countries gradually getting so high as to threaten almost a total cessation of intercourse. Prosperity, contentment, and rapid development, which in Canada would follow the obliteration of the McKinley Bill along the whole northern border of the United States, is not likely to lessen the loyalty of Canadians; and if their loyalty is likely to be affected by such a condition, the sooner England ceases to rely upon it the better.

What was to be hoped from the congress recently held in London was some expression of opinion by the British representatives as to the consequences of a discrimination against British manufacturers, and the real loss to them should exclusive Free Trade between the United States and Canada be attained. This loss at best must be excessively small, for the total exports to Canada do not exceed three per cent. of the total exports of the United Kingdom. Even if it were much greater it would be but a mere bagatelle compared, first, with what Canada suffers from isolation and loss of population: and, second, it would be turned immediately into profit should the development of Canada be at all proportionate with that of the United States. This is proved by the following table, showing the increase in trade between the two countries in fourteen years preceding 1889, a comparison which makes the vociferations of loyalty from Canada seem almost ludicrous if that loyalty is sufficiently sincere to find expression in the shape of profit to Great Britain:

Great Britain's Trade.	1875.	1889.	Increase.
With Canada.....	£20,000,000	£21,500,000	£1,500,000
With United States.	94,000,000	144,000,000	50,000,000

Five millions of loyal British subjects in Canada increased their trade with Great Britain in fourteen years a paltry million and a half, while sixty millions of supposed commercial enemies in the United States increased it fifty millions sterling, indicating that each Canadian increased the trade six shillings, while each American increased it sixteen shillings!

The gain to Great Britain by the closest possible relation between the English-speaking people that together hold the continent of North America in common is beyond estimate. Her investments, the profit from which immensely exceeds the profits of her trade, yield now a net return from Canada of £7,000,000, and from the United States of £40,000,000. These would be immeasurably improved, while the opportunity for the employment of more capital in development, which would be certain to occur, and the increase of trade from the growth that would follow, would enlarge the area of opportunity, such as would occur nowhere else in the British Empire. Although the congress did not discuss the question of unrestricted reciprocity between Canada and the United States, because of its supposed disloyalty, it is in Canada naturally a burning question, and, were it only an economic and not a political question, a vast majority would vote for it. Hence, notwithstand-

ing that it was so perfectly ignored, it is certain to have an important bearing on the relations hereafter to exist between Great Britain and her greatest of colonies.

In the policy of unrestricted reciprocity is found not only all the elements of the earliest and greatest prosperity to the three great parties concerned,—viz., England, the United States, and Canada,—but in its adoption will be found a more certain perpetuation of the presence of Great Britain on the continent of North America than under existing conditions appears to be promised, for a continental commercial unity has all the elements of material advantage of a political union, which is unnecessary, undesirable, and would be rendered thereby impossible.

POLITICAL reciprocity has had such a conspicuous airing this week [September 8], that a very important movement in the interests of practical reciprocity has passed almost unnoticed. We refer to the convention held at Grand Forks, N. D., last week to promote reciprocal trade between this country and Canada. Delegates were present from both sides of the border, and after several sessions given up to amicable discussion, the following resolution was unanimously adopted :

"Resolved, That in the opinion of this convention the conditions of the great Northwest on both sides of the international boundary make it desirable that all restrictions in the way of trade between the two countries should be removed as far as the same can be done consistently with the revenue requirements and other interests of the two nations at large."

Further and more definite steps will doubtless be taken at an adjourned meeting to be held at St. Paul some time within the next six months. A prominent business man of that city, Mr. E. S. Warner, in urging the invitation to meet there, said that "the business men of St. Paul and Minneapolis were in favor of fair reciprocal trade relations with Canada *and all other countries.*" The politicians who have thus far juggled with reciprocity as a political trick and make-shift will eventually see that they must give up their petty, half-way measures, and come around to the demand of the great business interests of the country. What the latter want is the abolition of obstacles to trade, and they are not very particular whether the process is called reciprocity, or free trade, or abracadabra, so long as they get the thing.—*New York Evening Post.*

COLONEL E. C. SMEED AND HIS WORK.

By General Herman Haupt, C. E.

IN the recent death of Colonel E. C. Smeed, Chief Engineer of the Union Pacific Railroad, the engineering profession has lost one of its brightest ornaments and the writer a most valued friend and former associate. A brief memoir may be of interest to the readers of this magazine.

In the spring of 1862 the writer, who was then engaged in the construction of the Hoosac tunnel, received a telegram from the Secretary of War requesting an immediate interview in Washington. The summons was promptly obeyed. The Secretary explained that the reconstruction of the Fredericksburg Railroad in the shortest possible time was a military necessity, to enable McDowell to advance, coöperate with McClellan, capture Richmond, crush the Confederacy, and end the war, and added that this would not require more than three months; and if the war was not finished by that time, he would resign.

With the understanding and assurance that the service to be performed would not require a permanent engagement, involving the sacrifice of very important interests, the position of chief of construction and operation of the United States military railroads was accepted; and after a conference with General McDowell near Aquia creek, an organization was made, tools and material provided, and in two days work was commenced and carried on without intermission, day and night. Cross-ties were cut in the woods, rails brought from Washington, and track laid at night, regardless of rain, by the light of lanterns.

All the bridges on the line had been destroyed. Of these two were of considerable magnitude and importance; one of these, across the Rappahannock, had been commenced under charge of Daniel Stone, an experienced bridge contractor, and a brother of Amasa Stone, of Cleveland. The other was the high bridge across Potomac creek, ninety-three feet high and nearly four hundred feet long. Stone was directed to furnish the writer with a portion of his foremen, and the unskilled labor was provided by a detail of three hundred men, common soldiers from the camps in the vicinity; and the worst feature of the arrangement was that the details

were changed every morning, so that nearly half of each day was lost in picking out the men who could use a tool of any kind.

Among the foremen who had been ordered to report for duty at Potomac creek was a young man named E. C. Smeed, who had been employed as a supervisor of one of the divisions of the Cattawissa Railroad in Pennsylvania, and had become experienced in the construction of trestle bridges. Smeed soon exhibited a most extraordinary ability in organizing forces and expediting the work of construction, combined with unfailing fertility of resource in adopting expedients to meet unexpected contingencies. He soon became the right hand of the writer and was placed in charge of the working forces on bridge construction. To him more than to any one else is due the remarkable results which astonished the military engineers of Europe and led the contrabands to declare that "these Yanks built bridges in half the time that it took the rebs to burn them down."

General McDowell stated in a speech in San Francisco that the Potomac creek bridge had been constructed in nine working days, by common soldiers of the Army of the Potomac. It contained over two million feet of lumber, cut in the woods and dragged by oxen to the site of the bridge. The legs of the trestles were round sticks not divested of bark, and the braces were poles five to seven inches in diameter, flattened at the ends and spiked. There was not a mortice or tenon in the structure, and it became the model for all the bridges subsequently erected on the military railroads.

President Lincoln passed over the Potomac creek bridge early the next morning after its completion, and on his return to Washington remarked to the War Committee that he had seen the most remarkable structure that human eyes ever rested upon. A bridge had been built across Potomac creek four hundred feet long and about one hundred feet high, over which trains were passing hourly to carry supplies to the Army of the Potomac, he said, "*and upon my soul, gentlemen, there is nothing in it but bean-poles and cornstalks.*"

After the completion of this work the Secretary of War was enabled to perceive the serious difficulties that attended the use of unskilled common soldiers in the construction of bridges, and consented to the formation of the Military Railroad Construction Corps, which became a marvel of efficiency. This corps consisted of about 600 able-bodied contrabands, 50 bridge foremen, and 200 men with a full supply of ropes, chains, and tools.

The writer was Chief of the Bureau, nominally in charge of all the military railroads, but practically in control only of those in Virginia, Maryland, and Pennsylvania. John H. Devereux, afterwards prominent in railway circles, and William W. Wright were assistants in charge of transportations. Adna Anderson, afterwards Chief Engineer of the Northern Pacific Railway, was in charge of road construction, and E. C. Smeed in charge of bridges. This corps accompanied General Sherman in his famous march to the sea, and it is more than probable that without the aid of Smeed this expedition, instead of a triumphant success, would have been a disastrous failure. The rapidity with which bridges were reconstructed and broken communications restored inspired so much confidence that advances were made in violation of established rules with long lines of unprotected communications in the rear. There was a feeling of security that, if bridges should be burned in rebel raids, they would be reconstructed so quickly that no serious embarrassment could result therefrom. It was during this march to the sea that Smeed performed the greatest feat in military bridge work that the world has ever seen in the construction of a bridge twice as large as that across Potomac creek in half the time, or four-and-a-half days.

In 1867, while in England, the writer received a special invitation to attend the meeting of the British Association for the Advancement of Science. At this meeting a member rose and stated that the accounts of the construction of military bridges in the United States during the late war had been considered on that side of the water as entirely fabulous. If such bridges had been constructed, he, and no doubt others, would like to know the means and appliances by which results so extraordinary had been accomplished, and as it was understood that the gentleman was present who had charge of this work, he desired that a request be made for an explanation. On motion of General Lefroy, of the Royal Engineers, seconded by Fairbairn, unanimous consent was given to the suspension of the discussion of another subject, and the explanation that followed elicited a vote of thanks.

To Smeed more than to any other was due the credit of results in the rapid reconstruction of communications, but the credit was given to other parties. Excessive diffidence was one of his most prominent characteristics; he shrunk from making himself conspicuous, and repeated requests for a detailed account of the work in the construction of the Chattahoochie bridge elicited no re-

sponse. It was intended to give him the credit which was his due, but he preferred to remain in obscurity. Smeed's early education had been limited, but he made himself an accomplished mathematician, and some of his letters to the writer on the theory of bridge construction and the distribution of strains in complicated trusses exhibited a rare familiarity with this intricate subject.

In 1882 Smeed had become Chief Engineer of the Kansas Pacific Railroad. The writer, then General Manager of the Northern Pacific Railroad, was authorized to offer him the position of Engineer of Road and Bridges on that line with a very large salary. Jay Gould, who had found out his value, bid more than the compensation offered and succeeded in retaining him. This was the reason assigned for non-acceptance. At the time of his death, in August, he was Chief Engineer of the Union Pacific system.

ELECTRICITY.

Conducted by Franklin L. Pope.

THE old-fashioned telegraphic constructor, with his primitive ideas in respect to insulation and wiring, has ever been a sore affliction to the modern electric-light engineer. As a matter of fact, the experience gained in telegraphic circuits has in most cases been more detrimental than advantageous when applied to the novel and exacting condition involved in the manipulation and control of currents of high potential and enormous volume. It is, however, interesting to note that the well-known peg switchboard of the telegraphic service, modified in form but not in principle, is more and more coming into use for the heaviest and most severe conditions. Experienced electric-light engineers now prefer marble to slate as a material for the base-board of switches, although a foundation of solid and heavy plank, thoroughly protected against moisture and having all the apparatus mounted upon incombustible bases, is still much in favor. It is a maxim in every well-constructed central station that every conductor shall be in every part in plain sight, so far as practicable.

ONE would scarcely expect at this late day to hear of any material improvement in the well-known gravity battery now so universally used throughout the United States not only for telegraphic but for numerous other electric services. A certain electrician possessed of an observant mind noted the fact that of the 5,000,000 (or so) pounds of zinc annually consumed in these batteries at least 30 or 40 per cent. consisted of waste pieces thrown away after having been but partially consumed. He thereupon conceived the happy idea of a compound zinc element, made in a form whereby successive new sections might be added at the top before the lower ones were consumed, and thus every grain of zinc be utilized. One cannot but profoundly admire that peculiar manifestation of inventive genius which occupies itself in remedying fundamental defects in common and familiar things, obvious enough indeed when once pointed out, but which are prone to escape the attention of everybody, especially of those most immediately interested.

IN the distribution of electricity from central stations it is obviously necessary for commercial reasons to furnish the current at certain standard voltages, which, by general consent, have been fixed in this country at 110, 220, and 500 volts. But in many industrial applications of electricity—such for example as electro-plating—the lowest of these standard voltages is unnecessarily high, and hence the current cannot be utilized without great waste of energy. A motor-generator has now been put on the market, which surmounts this difficulty in a way that is both scientific and practical. The machine may be wound to take a current from 600 to 6 volts and to deliver one at from 6 to 600 volts. It is, in fact, a continuous-current transformer, and must find extensive application for electro-plating, charging storage-batteries, generating currents for telegraphic work, operating dental and other light machinery, and so on. A machine of this kind weighing thirty pounds will do the work of 250 cells of ordinary gravity battery.

PROFESSOR BLYTHE, of Scotland, has made quite a successful attempt to supply himself with electricity by wind-power. He constructed a horizontal wind-wheel on the principle of the anemometer, having four arms, each twenty-six feet long, carrying semi-cylindrical boxes at the ends, ten feet by six. The wind-wheel is geared to a dynamo, and in a fair breeze is said to develop about two electrical horse-power. If some one would undertake to keep a

continuous record for a year, or better still for a term of years, of the actual power that can be derived during the time from a wind-wheel of given dimensions, it might be possible to establish a basis of computation from which results of commercial value could be worked out. So far as we know, no such determination has ever been made. Of course the storage-battery would necessarily have to play an important part in any scheme of this kind.

A GLANCE at the maps and statements of railway mileage contained in the last volume of "Poor's Manual," lately issued, raises the inquiry whether any considerable addition is likely to be made in future to the steam-railroad trackage of some of the older and more densely populated States, such as Massachusetts, Connecticut, and New Jersey. In Massachusetts, for example, the mileage has only increased during the past eleven years from 1915 to 2100, and this consists mostly of small local branch lines. Every day's experience demonstrates more and more conclusively that many of these local lines can be more cheaply constructed and more profitably operated by employing electricity as the motive power. Not only will many new roads be thus equipped, but the competition which is now going on in many places between parallel local and suburban lines operated respectively by steam and electricity will in all probability demonstrate that the change to the new power may be advantageously made, even on some of the existing steam lines, where conditions are favorable. It would not be surprising, therefore, if the next ten years should not only fail to record an increase in steam-railway mileage in some parts of the country, but should even show some decrease. It is quite evident that a revolution is impending in this department of transportation.

A WRITER in *Electrical Industries* points out that the item which appeared in this department in August in reference to the extent to which electricity has been adopted as a motive power for street-railways is very much behind the times. We therefore make amends for this unintentional oversight, so far as possible, by stating that the June issue of *Electrical Industries* reported 425 electric railways in the United States, with an aggregate of 5072 miles of track and operating 6477 motor-cars, since which the same journal has reported 14 new roads, which when completed will operate 164 motor-cars on 98 miles of track.

RECENT returns of the business of the West End Street Railway Co. of Boston give information of great value respecting the actual financial results of operation by electric power. This company is now operating about 1,000,000 electric car-miles per month, the increase in two months being 150,000 car-miles. Notwithstanding this increase of 15 per cent. in the work done, the total cost of motive-power shows a decrease of about $3000. The figures for July show that the cost per car-mile for electric power was 5.22 cents as against 11.36 cents for horse-power. The total of all kinds of operating expenses foot up for the electric-cars 21.87 and for the horse-cars 26.14 cents per car-mile. Such results as these call for no comment. Decreased expenses mean improved service and increased facilities in every way.

AMONG the electrical wonders of the World's Fair will be large dynamos capable of supplying 20,000 16-candle incandescent lamps. These will be driven each by a 2000 horse-power direct-connected steam-engine. The applications for electric current to drive machinery at the Fair far exceeds the present capacity to supply, and it looks at present as if the electrical features of the exhibition would throw everything else literally in the shade.

A NEAT photographic process for obtaining a representation of the magnetic field is suggested by Professor E. J. Houston. A sensitized gelatine plate is introduced into the magnetic field, in the dark-room, and iron-filings carefully dusted over its surface, after which it is exposed for a second or two to the light of a gas-flame or match. The filings are then

removed by a camel's hair brush, and the plate developed by the ordinary photographic process. A sharp contrast may be produced in the negative by the use of bromide in the developer. Any number of prints may of course be made from the negative.

A CIRCULAR in reference to incandescent lamps has been issued by Siemens & Halske, of Berlin, one of the largest electrical manufacturing concerns in the world, in which it is stated that an experience of many years has shown that the most advantageous lamp, from the customers' point of view, is one which consumes from 3 to 3½ watts per candle-power for all sizes of lamps between 10 and 50 candles, and that, at the present prices of lamps, those which are supplied from central stations ought not to exceed 3 watts per candle-power. This agrees very closely with experience in this country.

A NEW departure has recently been made in New York city in the way of electric street-lighting. The new arc lamps on Fifth avenue have been placed on posts in pairs, each lamp taking 5 amperes at the usual voltage. Each pair of lamps is connected in multiple on a low-tension circuit, thus permitting them to be fed with current from the same mains as the ordinary low tension domestic service, and rendering a special circuit unnecessary.

PROFESSOR NICHOLS, of Cornell University, is investigating the law of radiation in treated and untreated incandescent-lamp carbons at different temperatures. His preliminary experiments seem to indicate that the carbon coating furnishes little or no conductivity, a result which at first sight is somewhat difficult to explain, because the process of hydrocarbon treatment is availed of during the process of manufacture as a convenient mode of equalizing the resistances of the different lamps. The subject is interesting and of great practical importance, and ought to repay thorough investigation.

AT the Tilly Foster iron mine near Brewster's, N. Y., a process of concentrating ore by magnetic action has been in constant use for two years. A report recently published states that during this period 27,462 tons of concentrated ore have been shipped, and that the cost per ton of making the concentrate has been reduced from $2.10 to $1.99 per ton, with every prospect of still further reduction.

THE electrical journals announce the invention of an automatic telephone-exchange apparatus which is intended to render the services of the "hulloa-girl" at the central station henceforth unnecessary. While such an apparatus is without question theoretically possible to be made, the obstacles apparent in the way of its general adoption are so numerous and so serious that we have little expectation of its ever being employed, except possibly in exchanges in which the number of subscribers is so small as not to warrant the expense of an attendant. In any system of this kind the liability to derangement and obstruction must necessarily increase nearly in proportion to the square of the number of the connections, and hence with any considerable number of subscribers we should expect to find that the cost of the highly-skilled labor necessary to keep such an amount of delicate and complicated apparatus in working order would exceed that now paid for central-office service.

IN a statement recently made to the stockholders of one of the leading gas-light companies of New York by its officers it was shown that for forty years prior to the introduction of the electric light the increase in gas consumption had been at an average rate of 10 per cent. per annum,—a ratio far more rapid than the increase of population. But since the introduction of the electric light this rate of increase, instead of falling off, as many too-easily alarmed stockholders in gas companies had expected, has risen, and much more rapidly than ever before. The consumption, which formerly doubled only once in ten years, has actually doubled within the past seven years, and it appears

to be conceded that at no period since the first introduction of gas as an illuminant have the prospects of that industry appeared so satisfactory and promising as now.

AN enormous switchboard has been built for an electric lighting company in Providence, R. I., which is designed to accommodate 40 arc circuits. It is 18 feet long, 10 feet high, and requires for its construction, besides considerable other material, no less than 3,500 pounds of marble and 1793 pounds of brass.

IN a discussion of the problems of commercial electrolysis before the British Institution of Electrical Engineers Mr. J. Swinburne observed that the arc, and in fact many forms of electric discharge, produce traces of nitrogen compounds, and suggested that if, under any commercial conditions, nitrogen compounds could be produced from air, the demand would be practically unlimited. A works situated on a waterfall would have its power and material provided, and the only cost of production would be the interest on plant and the wages of one or two men to look after the dynamos.

THE electric motor has proved itself to be especially well adapted as a motive power for hoisting-machinery. The most approved designs of electric cranes are equipped with three motors, one for each motion, a 15-ton crane, fitted with a slow-speed motor of 10 horse-power running at 200 revolutions, geared to the intermediate shaft. Carbon brushes are usually employed in motors for this work.

DR. JOHN HOPKINSON, as a result of a careful test made by him, finds the efficiency of one of the best types of modern alternating transformers to be 96.9 per cent. at full load, 96 at half load, and 84.7 per cent. at quarter load. The transformers tested had a rated capacity of 6500 watts each. This may be regarded as a very satisfactory result.

MR. C. H. YEAMAN, in a letter to the *Electrical Review*, makes the excellent suggestion that some definite size of electric lamp be fixed upon as a basis for calculations. He recommends the adoption of the 50-watt lamp for this purpose, on the ground that it is a common and convenient size for interior illumination, and that it gives round numbers,—20 per kilowatt. It is to be hoped that something of this kind will be done.

IN some of the latest designs for the installation of electric-power plants the amount of floor space required, including boilers, engines, dynamos, and all appurtenances, has been reduced to about 5 square feet per electrical horse-power.

THE North Chicago Street-Railway Company has had in operation for several months a section of electric street-railway in which the conductors are laid in an underground conduit, embracing four curves and a number of crossings and switches. The officers of the company speak very highly of the results thus far attained. It is certainly to be hoped that a satisfactory solution of this most difficult problem has at length been found.

IT is announced that all the remaining street-railway lines in St. Louis are to be equipped with electric motors. The work will involve an expenditure of $2,000,000.

IN a communication to the British Association Committee on Electrical Standards, Dr. Oliver Lodge makes some suggestions of practical interest. He insists that names ought to be given to complete things dealt with, and not to mere coefficients. For example, volts and amperes are active things, with which every electrical engineer has to deal, and for measuring which instruments are (or at least ought to be) found in every electric-light station, while the ohm, or unit coefficient of resistance, is comparatively academic in its character. It is the drop in potential which a given conductor entails for a given current that is of real interest to the engineer, and of which he consciously thinks. A more useful name as regards conductors would

be the reciprocal of an ohm, the ampere per volt for which Sir William Thomson once suggested the preposterous name of *mho*. The whole object in devising a system of practical units was to have things of every-day size to deal with. The volt, ampere, and ohm satisfy this condition, but the coulomb, farad, and watt do not, and hence these last have practically given place to the ampere-hour, the microfarad, and the kilowatt. It is more natural, Dr. Lodge thinks, to give a name to a definite thing, like a quantity of energy, than it is to give it to a mere rate of working, which is instinctively felt to need a reference to time to render it thinkable.

NOTHING could be much more unsatisfactory than the present status of electrical insurance inspection in this country. The utter lack of uniformity of rules and methods leads to endless confusion and controversy, and the results of this state of affairs are fast bringing the whole matter into disrepute. Reputable wiring contractors, no less than insurance companies, ought to be interested in the establishment of one set of authoritative and sufficient rules, and we are glad to note that a determined effort is being made, with a good prospect of success, to bring about this most desirable result. In England there has been, from the first, an excellent system of rules and inspection, to which both electrical companies and contractors have apparently been entirely willing to conform. At all events, it is asserted, apparently upon good authority, that there has not been as yet a single fire in that country which was traceable to electric wires. It is scarcely necessary to say that what is possible in England is possible here. There is altogether too much wiring in daily use in this country that is about as bad as it can possibly be.

MR. ALEXANDER SIEMENS has made public some interesting figures in reference to the workings of the City and South London Railway. The electric locomotives are of 100 horse-power capacity, and when ready for service weigh about 13½ tons. The train load, exclusive of passengers, is about 21 tons, requiring for ordinary running a current of 50 amperes, but rising to as much as 140 amperes when starting under a heavy load. The average speed is about 13 miles per hour. The item put down as "locomotive expenses," which was at first 18 cents, has been reduced to 15.5 cents per train-mile, which compares favorably with the cost of steam-locomotives in England.

WE frequently hear it said that the storage battery has reached a much greater degree of perfection in Europe than it has in this country, but nevertheless we observe that two more additions to its long and dreary catalogue of failures in street-car traction are chronicled in our English exchanges. It appears that the North Metropolitan Tramway Company of London, after four years' continuous experience with accumulator-cars, has definitely abandoned them and resumed the horse service. The figures for the year show also that the Birmingham Central Tramway Company has made a heavy loss on its accumulator electric-car business, a striking contrast to the almost uniformly profitable results of operation by direct electric distribution, not only in this country but abroad.

PROFESSOR VON HELMHOLTZ, at the recent meeting of the British Association, stated that, as the result of various determinations of the standard ohm made by different physicists in England, France, and Germany, a standard ohm equivalent to a mercury column of one square millimeter cross-section and 106.3 centimeters in length is correct to about 1 in 10,000,—a degree of accuracy which he considered sufficient for industrial purposes for centuries to come.

A HIGH-PRESSURE water-service is now in operation in Geneva in which water is pumped into a reservoir by turbines in the Rhone. In 1889 the motive-power distributed aggregated 1,500,000 horse-power-hours, there being 79 motors representing 1279 horse-power in all. In Zurich

there is a similar system, furnishing 9,000,000 horse-power-hours per annum. All the electric lighting, both in Geneva and Zurich, is done by dynamos driven by turbines using pumped water. The advantage of this apparently roundabout method of working arises, in these particular cases, from the circumstance that the water-power has a low head and variable flow, necessitating large turbines, which cannot be run at a regular speed. By setting these to pump into a high-level reservoir, they may be worked under a constant load during the whole twenty-four hours. The actual work at the consumer's premises is done with small high-pressure turbines, under a constant fall and running at a regular speed. These are easily adjusted by governors to a varying load, and are capable of being used in units of any required size without loss of efficiency.

A CORRESPONDENT of the *English Mechanic* writes that he had the misfortune to break off a tap in a half-inch hole at the end of a shaft. After trying unsuccessfully to soften it by the blowpipe, he bethought himself of trying electricity, and accordingly, by means of an arc-light carbon, brought to bear on the shaft an electric current of 30 or 40 amperes, which raised it to a dull red heat in about three minutes. When cooled the tap was of course easily drilled out.

A WRITER in the London *Electrician* thinks that perhaps nothing has done more to develop and improve the continuous-current dynamo in that country than the stringent conditions as to weight, size, and heating, which had been laid down in the Admiralty specifications. He very justly observes that neither maker nor buyer has any idea of the possibilities which are within easy reach unless some such powerful incentive to progress is felt.

MR. C. E. L. BROWN, formerly of the Oerliken works in Switzerland, who is one of the best authorities on questions of electric-power transmission, says that his experience shows that there is no material difference between the two-phase and the three-phase systems of distribution by alternating currents in respect either to efficiency, starting torque, weight of machinery, or apparent consumption of energy. He expresses the opinion, in which he is supported by many other electrical engineers, that in the future, where combined light and power-distribution is required, the two-phase current will take the lead, although the three-phase current may be preferable in some cases for simple power transmission and distribution.

IT has always been considered an important advantage of the ring over the drum type of armature winding for dynamos and motors that the former may be more thoroughly ventilated, so as to permit the heat generated to escape and not accumulate to such an extent as to injure or destroy the insulating envelop of the conductor. A recent improvement, in which the ends of the conductors are bifurcated, provides an air passage between the end conductors and the core of a drum armature, not only securing adequate ventilation, but rendering it possible to replace any individual bar, without disturbing the others. This new type of winding appears to combine most of the advantages of both the old types, and is coming into extensive use.

MR. H. E. VINING, in a communication to the *Electrical Engineer*, discusses the economical advantages which would attend the use, in systems of direct distribution, of incandescent lamps of much higher voltages than the present standards. He shows that by the use of such lamp, not only would the capacity of the existing mains be doubled, and in some instances trebled, but the area of profitable distribution would at the same time be enormously increased. Mr. Vining observes that the quality of glass used in the lamps is an all-important point, but believes that the ultimate solution of the problem of high voltage will be found in the chemical treatment of the fiber of which the carbons are made, rather than in a resort to mechanical expedients, such as the elongations of the filament.

MECHANICS

Conducted by Frederic R. Hutton.

IN *Harper's Magazine* for August, 1892, appears a most interesting illustrated article by T. Mitchell Prudden, discussing ice and its manufacture. The article is delightfully lucid in its discussion of the scientific aspects of the formation of ice, and the illustrations taken from photographs of ice blocks are singularly instructive. As the author puts it, the heat of the sun stored in the coal by which the ice was manufactured shows, when permitted to unlock the compacted particles of ice, the crystalline structure of the mass; and it is to this feature of the subject that the engineer may turn for a most profitable lesson. It was brought out over forty years ago by Robert Mallet in his investigations into cast-iron ordnance that crystallization in a body with corners takes place with the longer axes of the crystals normal to the cooling surface when a body is passing from the fluid to the solid condition by the crystallizing process. As the ice block passes from the fluid to the solid condition by the absorption of heat, or, to speak exactly, by the diminution of heat-energy in its particles, so also does the casting of iron or of steel; and the phenomena which show themselves in one may be expected to repeat themselves in the other. The translucence of ice permits the development of this crystalline structure and the arrangement of the crystals to make themselves manifest to the eye. The practical opacity of iron and steel even in the very thinnest sections makes it very difficult to show the exactness of the analogy, but it often appears upon a fracture in a body of rectangular section, such as an ice block usually receives. If the crystals are arranging themselves normal to the four bounding sides of the block, there must of necessity be at the corners lines where the crystals will, at best, be what the crystallographers call geniculated, so that two crystals join with the end of one against the side of the other, as in a knee-joint, or else the crystalline structure is unhomogeneous and interrupted. Whichever state of affairs exists, there must necessarily be at these corners lines of weakness, which will develop themselves possibly to the prejudice of the strength of the design. In a casting which is to act by its strength, this interruption of the crystalline structure will occur at every salient and at every re-entrant angle of the design, and will be present in proportion to the sharpness of the angle. We see therefore what an error it is to plan for sharp corners in a casting, and how much a re-entrant angle is reinforced by filleting at that point.

It is obvious, moreover, that a large casting, which by reason of its mass will cool slowly, is more likely to be the victim of these difficulties introduced by the crystallizing process than a small one, where the cooling is rapid. It is well known that in the formation of crystals from saturated solutions, where the formation is allowed to go on very slowly, the surest method is taken to produce crystals of large size. The larger the crystals, the greater will be the molecular interstices between the particles, and consequently, in a disturbed arrangement, the more unmistakable will be the development of the weakness line. It is equally obvious that, if by any means the cooling can be accelerated along the lines where weakness from this crystallizing process would naturally show itself, the more thoroughly is the difficulty from them eliminated from the design.

The ice block also shows the presence and development of the pipe, which is the source of weakness in ingots and castings poured on end, and the contraction which must of necessity take place in cooling. As the solidified mass cools from the outside towards the center, necessity compels that there be left in the middle of the vertical cylinder or prism a center where

the metal will not be as dense as on the edges first cooled. This lack of density towards the top of the ingot or prism will amount to a hole wherein is no metal at all, or no ice crystals in the block; because the fluid material has run down by gravity to fill the cavity formed further down the cooling mass by the solidifying and contraction near the bottom. Moreover, as the mass cools from the outside, that part which has already solidified increases the thickness of the non-conducting covering which surrounds the center, retarding the cooling and compelling it to take place slowly. By the process of slow cooling we get a larger crystalline structure in the middle, and this larger structure in the middle—the heads of the crystals radiating from the axis—introduces the same difficulty as was shown at the diagonals of the rectangular prisms when viewed in section. The center will not be as homogeneous and dense as the other and exterior parts for this reason, even if a full supply of metal was given to it.

This analogy and discussion show the reasons and necessity for what is known in the foundry and casting practice as a feeding-head. A mass of fluid metal upon a level in the mold higher than that occupied by the pattern itself will furnish fluid metal to run down into this pipe as it develops itself in cooling, keeping it full of material ready to solidify, and by its head of metal exerting a pressure sufficient to press the fluid metal into the lower interstices. The feeding-rod used in the foundry has a similar object, tending to keep open a channel through the fluid feeding-head, by which the supply of fluid metal can continuously reach the part where it is needed. Of course, as the metal solidifies, the rod must be gradually pumped to a less and less depth until finally withdrawn.

THE recent calamity in Western Pennsylvania, where bursting tanks of burning oil have carried horror and devastation to all the lower levels which the oil could reach, has provoked considerable discussion as to the danger which threatens other districts of the country from this cause, and has made a call for the burying below the ground level of such reservoirs of uncontrollable energy as these are shown to be when fire once gets into them from lightning, or rampant electricity in other form, or accidental sparks. This danger is present in manufacturing enterprises where the work to be done involves the use and storage of any inflammable fluids. These are not, as a rule, extinguishable by water, inasmuch as they are usually lighter than water and will float on its surface as fluids, and, when gasifying and hot, will float even though normally heavier than water. The excess of water therefore running off from the building carries with it the burning oil to ignite other buildings, and the very water by which it is sought to extinguish the conflagration becomes the means for extending it. A disaster of this type, occurring in a large manufacturing establishment in Connecticut, brought the matter to the attention of its clear-sighted and capable president, and the result was a new building so constructed that at the entrance at the ground level there were several descending steps to the level of the floor. By this simple expedient, the building below the ground was a tank within which could be limited the area of conflagration if any should take place.

A PROBLEM of a similar sort was solved most ingeniously by W. F. Durfee, mem- of the American Society of Mechanical Engineers, at a large sewing-machine establishment where Japan kettles had to be used; which, of course, are particularly liable to ignition if at any time so heated that the volatile constituents can spontaneously ignite with the oxygen. Besides lowering the level of the hearth within the brick chimney where the kettles were placed, a heavy door of non-combustible material was fitted to the chimney-breast, so arranged as to slide in guides and practically close the chimney-opening air-tight when down. This door was held up by a chain connection with a fusible link within the chimney, the alloy being so chosen that the ordinary temperature in the flue would not melt it. Should either of the

kettles catch fire, the increased temperature in the flue would melt the fusible link, release the detaining chain, and permit the fall of the door, thus cutting off the access of air to the flaming kettle, confining the flame to the incombustible chimney, and gradually leading to its extinction.

AN interesting illustration of the danger familiar to boiler experts from the attachment of massive fixtures to those plates of a boiler exposed to pressure has recently been reported in the *Engineer* of London. It is very usual in traction engines and in many varieties of portable or semi-portable engines using horizontal boilers of the locomotive type to put the engine or machinery bearings on the top of the boiler, using the latter as a frame or bed-plate. In the design of the apparatus in the illustration referred to, it was found that corrosion had taken place on the outside of the shell under the engine-casting, where of course it could not be detected in the ordinary method of inspection, and had so thinned down the boiler plate that only the strength of the iron forming the casting was the dependence for the transfer of the strain from one side of the corroded spot to the other. The design of the holding rivets is rarely made according to the calculations of the boiler seams in such cases, and, even if it had been, there was the considerable danger of depending on the cast iron for the withstanding of boiler strains. No one would dream of putting a cast-iron patch over a hole in a wrought-iron or steel shell; and there seems no physical reason why the boiler should not have given way, resulting in a disaster. In locomotive practice, while the cylinder saddle is attached to the boiler, the attachment is to the smoke-box sheets, and not to those parts of the shell exposed to pressure from the inside.

SINCE the question of providing facilities for internal transportation about the enormous areas of the Columbian Exposition has been before the authorities for consideration, nearly every one has heard of the movable sidewalk idea. An experimental illustration of it is now in place upon the grounds. A movable platform carried upon wheels is caused to advance at the rate of three miles an hour. There is no difficulty in stepping upon a platform moving at this rate. This platform is borne upon axles of wheels which roll upon a track at this speed. Upon the tops of the wheels is borne a second platform, which of course must have the velocity always that of the upper part of a rolling wheel, or twice that of the axle, and therefore moves at a forward velocity of six miles an hour. If there is no difficulty in stepping from a position of rest to a platform moving at the rate of three miles an hour, there is no difficulty in stepping from this platform to another moving three miles an hour faster, and by this expedient a reasonably rapid motion and a continuous one is made practicable for the thousands of people who are not abundantly active.

This solution has the great advantage of handling almost unlimited numbers of people, whereas any system of trains broken up into units will always result in an accumulation of crowds at the stopping points, and the unit of carrying capacity cannot be varied to meet such congregations without taking valuable time for the shifting of cars.

On the other hand, the drawback to this scheme comes from the very fact that the entire plant of sidewalk must be run to carry only the two or three persons who may at that particular time desire to make use of it.

An extension of this same principle for the transportation of crowds up and down stairs has been made by J. W. Reno, and has been recently illustrated in the *Engineering News*. The plan involves an apparatus strongly suggestive of the horse-tread power with which the threshing and wood-sawing is still so generally done where the steam engine has not found its way. At the top and bottom of the staircase are sprocket wheels, over which passes an endless band of transverse slats carrying a convenient hand-rail. The person desiring to ascend the stairway simply steps upon the movable platform, steadying himself by the hand-rail, and is lifted

without exertion to the desired elevation, where he simply steps off. The continuously-moving stairway will of course accommodate many more people than the elevators making stops for this purpose. There can be no crowding or congregating, such as we are accustomed to see in buildings operated by elevators; and if allowance is made for the delays in waiting for the elevator, the speed is practically as great. The difficulty of the apparatus as compared with the movable sidewalk is that the stairway is not continuous, and the person ascending must be ready to step off at the stepping-off place; otherwise he (or more probably she) will be thrown down. In the movable sidewalk an accident of this kind can scarcely be expected. It would hardly be applicable, however, to buildings of many stories.

THE construction of very high buildings of the iron-skeleton type, in which rolled iron or steel beams form the frame work and the walls are simply a weather-casing performing no functions of support to the floors, is a type where the engineer has invaded the province formerly occupied by the architect. It is a question, however, whether in many cases the present generation is not sowing a form of active ventilation from which a succeeding generation will reap the whirlwind.

It is customary to paint these enclosed structural members and then to cement closely around them and carry up the brick work enclosing the whole. Provided the joint between the cement and the iron is perfect, so that moisture and air containing carbonic acid are kept from contact with the metal, all will be safe enough. Examples are on record where the iron thus enclosed in cathedral and other structures has lasted for centuries, and would probably have lasted for as long in the future if it had been left undisturbed. But the difficulty is that we cannot be sure of such intimacy and permanency of contact and of the entire safety of the metal work from corrosive influences.

In the first place the paint is at best a skin upon the surface of the metal. It does not enter into it by any sort of interpenetration, and shows in time a tendency to flake off.

In the second place, the iron expands under the action of heat and contracts under the action of cold by a co-efficient which is considerably different from that of the brick work. While of course this is strictly provided for in the design as a whole, yet the motion of the iron within the embedded masonry must result in the formation of a break in the joint between the iron and the cement, within which the access of air can occur.

In the third place, the capillary action of bricks upon water is well known, and, while cement is much less liable to this tendency, it is not free from it, and water may be thus drawn in to find channels of descent as it condenses upon the metallic verticals and be again the occasion for corrosion.

In the fourth place, it would be a serious state of affairs should it be found that the compression members upon which the multiple floor systems in a large building are supposed to rest had suffered by corrosion so as to be no longer able to perform the work. In warehouses the central pillars in open floors and kept covered with paint would still discharge their duty and uphold the central part, but in offices and partition buildings it is not pleasant to reflect upon the criticisms which future engineers would be likely to make.

FOR the protection of exposed metal work in structures or machinery there are three usual methods available for the engineer. The first and more usual is painting,—with lead, iron, silica, or bituminous paints. The iron paints are cheapest, and on extensive structures the most usual. The bituminous are more efficient than the iron, particularly for metal work which is to be exposed to the organic and mineral acids which iron work, such as pipes, etc., is likely to meet under ground. It would be the most efficient for the covered members of such cellular structures as are referred to in the previous paragraph, by virtue of its elasticity and its ready adaptability to the expansion and contraction of the metal under it.

A form of graphite paint has recently been put upon the market for boiler smoke-stacks, which form a most difficult class of structures upon which to keep paint, because of their variations in temperature, and which, by reason of their occasional high temperature, are particularly liable to corrosion. The asphalt paints, however, are not fancied by housesmiths, who do not mind a drop of iron paint from an upper story as they work below the painters, but are particularly opposed to the black drops from an asphalt pot.

The protection by another metal is most frequently met in the form of galvanized iron as used in wire, sheet-metal cornices, and pipe. Recently, however, as reported in this department, aluminum on copper has been applied in this way to protect cast iron, and in nickel plating and brass plating for the same object the principle is extensively applied upon a small scale.

The third method is the scheme of producing upon the iron a coat of one of the oxids which is not liable to rust. Of this method the Bower-Barff process is one of the best known on a large scale; and the process using niter and the peroxid of manganese is applied for small work, such as gun and pistol parts in the armories.

THE demands of high rotational speed in steam-engine practice have called for a type of lubricating apparatus which shall supply oil in excess. The investigations of Prof. Denton, of Stevens' Institute, Hoboken, N. J., and those of Dr. Charles B. Dudley, of the Pennsylvania Railroad, Altoona, Pa., members of the American Society of Mechanical Engineers, have shown that oil in thin films loses its lubricating quality by oxidization and by contamination from dirt and abraded particles, if it remains too long between the contact surfaces. In view of this state of affairs, the principle of sight-feed lubrication, as it is called, has become well-nigh universal in engine practice, whereby a continuous feed of oil in drops at a certain rate per minute can be secured; the oil flowing from a cup through an opening of graduated size and distributing itself over the bearings. In some cases arrangements are made to catch the overflow of oil from the bearing, and after filtration to use it over again. This is possible in bearings where centrifugal force may not be so active as to make it impracticable to accumulate this surplus. Crank-pins and the mechanism of shaft governors are illustrations of places of this class, and it is from them that the oily atmosphere of so many engine rooms mostly derives its supply.

IN the marine engine or similar engine of many bearings the practice of distributing oil from one cup through pipes to a number of different places has received very general adoption; and a form of such cup has been recently brought out in Denmark, and is seeking introduction in this country. From the bottom of the cup a number of tubes pass to the points to be lubricated; a cylindrical plug fitting a corresponding casing has holes bored part way through the plug opposite these outlets in the bottom. By rotation of the plug the holes point upward and fill with oil from the supply in the cup. As the plug rotates, the holes enter the plug cavities, pass within the casing, and receive no more oil, but the amount in each cavity is discharged into the delivery tubes when the cavities point vertically downwards.

By varying the speed of the rotation of the plug the frequency of discharge of the quantities held by the cavities is varied, and of course their original volume and capacity will be fixed by the amount which it is desired to feed at one time.

The plug is rotated by a ratchet wheel and dog, the length of the arm being adjustable to vary the feeding speed. The delivery tubes have an air-pipe, so as to avoid the holding of the oil by a pipette action when the plug closes the top of the tubes.

THE immense masses which are being introduced into the frames of high-power steam-engines in modern practice have brought out a variety of special machinery

intended to perform several operations upon the mass with one chucking operation. It happens not infrequently that the time consumed in transporting and securing a large piece upon the working-table of a machine-tool takes as much or more time than the operation to be performed.

An interesting example of a tool of this description has recently been brought out in England and is reported in the *Engineer*. It is intended to be a combined planer and slotting machine, so that members can be finished at once upon surfaces at right-angles to each other in the horizontal and the vertical plane. This requirement compels an extra heavy tool-holder and two horizontal rails for it to move upon, making an exceedingly rigid construction for the tool when used as a planer. The bed has the usual lengthwise, crosswise, and circular feed motions of the slotters, the longitudinal and transverse feeds being capable of having their driving gear so connected by change wheels that the cutting point can be made to follow a given taper from the line of the longitudinal feed.

IN a form of a cutting-off saw designed by a machine-tool works at Philadelphia the bed of the machine is mounted, so as to have a motion of horizontal angular adjustment around the axis of the circular bed. This design makes it possible to work upon heavy and long beams without the shoproom which would be required if the beams had to be presented to the saw-blade at varying angles.

The long beams can always lie in a designated position or at a special angle, and the adjustment of the saw-blade around the vertical axis of the machine gives the adjustment required for varying planes for the ends.

THE question whether a combination tool is better or more economical than several tools is one which continually presents itself.

The answer must be determined partly by the design of the combination tool and partly by the use to which it is to be put. If the combination tool, by reason of multiplied motions, becomes complicated to handle, or worse still, by reason of a multiplication of bearing surfaces, permits much lost motion, marring its accuracy, the single tool will be the better.

Moreover, if there is work of the same kind sufficient to keep one of the elements of the combination busy all the time, the simple tool is the better. In small shops, however, it is often impossible to keep all the simple tools full, and in this case the combination will be the better. This is aside from the question of such tools as above described, intended for special classes of work, where the combination justifies itself as necessary for the purpose.

A RECENT introduction of a number of patterns of cold-saw cut-off machines calls attention anew to the increasing analogies in the treatment of metal and wood. It is not so many years ago that the first sawing machine was attempted, and took the place of the laborious and unsatisfactory process by chisel and hammer for the cutting-off and squaring of beams, bars, ingots, and other shapes. Now, however, the saw is freely used, cold as well as hot, and with great advantage in labor-saving and in accuracy of work. The cold saw is not only used in the form where the saw is a revolving disk, but also in the form of a band-saw, and in this latter use it becomes possible not only to use it as a cutting-off machine, but also, when a narrow blade is provided, for work comparable to that expected of a scroll-saw in wood.

THE Wellman Iron and Steel Company have permitted recently the publication of the details of their new mill for rolling steel plates. This mill has the phenomenal capacity for rolling in one piece plates seventy feet long and eleven feet wide, if such should ever be called for. The advantage which attaches to the use of plates of such large proportions is that structures of corresponding size can be made up from them with a diminished number of joints, and in boilers, girders, and similar work there will doubtless be a continual and increasing demand of this sort.

ARCHITECTURE.

Conducted by Barr Ferree.

THE cholera is upon us: after weeks of anxiety and effort to escape the much dreaded evil it has sprung up in the midst of New York without so much as a clue to its origin. At first glance a discussion of cholera would seem not to come directly under the head of architecture; unfortunately the connection is only too close .In the interesting paper, "How We Can Guard Against Cholera," by Dr. George F. Shrady, which appears in another part of this magazine, some of the sanitary and engineering phases of the disease are ably discussed. But there is an architectural side to the question, quite as important as these, which it would be well to glance at briefly. Cholera thrives on dirt and filth of every kind; its invariable history, each time it has spread around the world, has been a progression from filthy communities in the east to scarcely more wholesome, and fully as dangerous, localities in the west. The sanitation of cities is as much an architectural question as the science of building or the art of construction. The spread of the disease in this country will depend as much upon the sanitation of habitations as upon personal cleanliness. The cities and the people must be wholly clean if the disease is to be prevented from becoming epidemic. Streets and houses must be scoured as they never were before; the greatest care exercised in the disposal of sewage and waste; the keenest oversight maintained over the water-supply, markets, and similar necessaries of life,—if we would escape the fate which has been portioned out to the city of Hamburg. And of all these things the strictly architectural element is not the least imporant. Cholera will take firmest root in old houses which are really uninhabitable through neglect and want of proper appliances. Unfortunately an architectural reformation, unlike a political one, cannot be accomplished in a single day. The sanitary condition of our cities has improved immensely of late years, but not one seaboard city is prepared for an invasion of the pestilence. Boards of health all over the country were never so active as now; abuses of all sorts are being uncovered daily, and evils repaired as speedily as possible; but the work must be more thorough than it can be when crowded into a few weeks, and must reach deep into the architectural horrors of our cities in order to be complete and satisfactory in its results. One further truth has already been brought home to every American, and especially to every New Yorker, in a way which it is to be hoped it never will be again, and that is the inadequacy of our permanent quarantine arrangements. New York suddenly found itself confronted with the problem of caring for two-score shiploads of passengers from infected ports, with no place to put them. The horrors which resulted from this long foreseen contingency are too well known to be repeated here, but the necessity for permanent and extensive quarantine accommodations is now obvious to all.

THE connection between plagues and architecture will be readily comprehended if we go back a bit into history. Few phases of medieval history are so mysterious and interesting as those relating to the pestilences which visited Europe from time and time and carried off an enormous number of victims. The exact nature of these diseases are not known to modern medical science, but whatever their nature there can be no doubt at all that they were caused largely, if not altogether, by the way in which people lived and the style of houses they lived in. The medieval houses were, many of them, wonderfully beautiful, but most unhealthy, and the people did not know how to make

them any better. An age in which one of the foremost physicians treated apoplexy with ants' eggs, scorpions' oil, and the flesh of lions, could do little in diffusing sanitary knowledge. Sir John Simon, formerly Medical Officer of Her Majesty's Privy Council, whose sanitary work under the British crown has given him a well-earned reputation, draws a dark picture of London immediately before the great fire, when the city was threatened by total destruction through the devastating effects of the plague. "From time immemorial," he writes, "successive generations of inhabitants, densely gathered there, had more and more befouled the ground. In great measure it had been as some besieged camp, where the surface incorporates every excrement and refuse, and where the dead have their burial-pits among the living. It had no wide streets for wind to blow through. In general it had only alleys rather than streets: narrow irregular passages, wherein houses of opposite sides often nearly met those above the darkened and fetid gangway. The houses themselves, mostly constructed of wood and plaster, had hereditary accumulations of ordure in vaults beneath or beside them. Unsunned, unventilated dwellings, they, from when they were built, had been saturating themselves with steams of uncleanliness, and their walls and furniture must have stored an infinity of ancestral frowsiness and infection." Doubtless it would be an exaggeration to say this describes any modern city, but the conditions depicted may be found in a close degree of approximation in any large modern town. We need to realize, more than we have yet done as a community, the important part architecture, and especially sanitary architecture, takes in our ordinary daily life.

It was in line with this connection between architecture and health that a paper read before the American Social Science Association, at its meeting at Saratoga in September, treated of "Architecture in Relation to Life." Calamities of world-wide interest, such as the cholera, bring home to every mind the important place architecture holds in relation to current existence. This relationship never ceases to be intimate, but so singular is the public estimation of the art that only something of surpassing interest fastens public opinion on it. Then there is a great awakening of interest. City fathers vote appropriations for sanitary measures; houses are ordered cleaned, even to their very roofs; cesspools and other foul places which have existed in close connection with dwellings for decades are closed up; the most frantic efforts are made to repair the architectural neglect of years. It is a question of architecture quite as much as of medical science. The art enters into current life in other ways than through sanitation. Neglected as it is by the people, it has managed to keep pace with modern requirements in a tolerably complete degree. Modern methods and inventions have called into existence myriads of structures that admirably answer the requirements of varied necessities which make up a large part of current existence. Modern systems of fireproofing make human life infinitely safer in crowded cities than it ever was before. Modern methods of construction, as exemplified in the high building, have perfected new systems of business, and are transforming our whole business methods. Modern ways of living are, in a great measure, dependent upon the houses in which people live. Architecture improves or makes worse the moral condition of the people. Bad tenements, for example, are inhabited by people of the worst grade; the more atrocious the architecture, the less desirable, as a rule, the tenants. Put these same people into decent houses, constructed on modern ideas, with improved sanitary appliances, and immediate improvement will ensue. Family life, which rests on privacy, is rapidly decaying in New York because the larger part of its population live in crowded dwellings. These questions are not simply sociological, as they are usually considered, but fundamentally architectural. Clothes, food, and houses are the essential and necessary accompaniments of civilization. Human life depends upon their quality and quantity. Not one can be dis-

pensed with, and of the three architecture is scarcely less important than the others. Certainly its place cannot remain empty, but until its importance is recognized, and its value in relation to current life admitted by all grades of society, civilization will remain without the advantage of having made the fullest use of its opportunities.

THE village of Chautauqua is one of the most celebrated places in America. The home of one of the most successful centers of popular education, designed and arranged by men of culture, it is the Mecca of thousands of intelligent students who look there for evidences of the most refined culture and advanced progress. Architecturally it is one of the most atrocious places on the continent. The houses, in themselves chiefly of an abominable style of architecture, are crowded together almost as closely as in New York city. There is scarcely breathing space between them. There is no sanitation, and the lack of drainage and sewerage is frequently unpleasantly manifested to visitors and native alike. The "streets," if such they may be called, are country roads of the roughest description. The water is obtained from the lake on which the town faces, and is daily polluted—to mention no other source—by a numerous fleet of excursion steamers. To crown all, the most pretentious edifice in the place, the Amphitheater, is a plain straight flat roof supported on poles, one side only being enclosed with a wall, in which an organ is inserted. It is hardly possible to conceive of a town wherein the most elementary rules of architecture and sanitation are more openly or apparently more gleefully violated. The condition of the place would be bad enough for an ordinary country village, but for an educational center, an offspring of cultured minds, a model intellectual community, it is nothing short of disgraceful. Of course decent sanitation and respectable architecture cost money, and the Chautauqua Assembly has labored, and is laboring, under a heavy debt. Further, plans are under active consideration for important changes and improvements, which, it is hoped, will materially affect the chief items contained in this indictment. These, however, will not alter the fact that the houses have been permitted to crowd together in one place, albeit one would suppose that, when a situation so remote from great centers was selected, ample room for healthful, cheerful building would have been had. It is simply another illustration of the old story of popular indifference towards architecture and ignorance of it, which is always the more alarming when cultured men, as was the case here, undertake to design architectural work. To one who has not seen Chautauqua in the height of its season, when from 15,000 to 20,000 human beings crowd its narrow limits, it is impossible to imagine the unspeakable horrors which must exist there, and which are not less marked, or less detestable because they may be overlooked in the enthusiasm of ardent study. An educational center like Chautauqua needs to be a model community in every respect. Practical architecture, as well as exercises in Hebrew accents, Assyriology, and surd roots, should have ample, practical illustration. The Chautauqua Literary and Scientific Circle has done too much for education in America for its headquarters to be a mockery of architecture and a positive danger to human life. A fresh mortgage on the town would be preferable to continuing its present unsanitary state.

THE World's Columbian Exhibition has precipitated upon us a mass of architectural literature, which is not the less interesting or important because it is chiefly confined, as yet, to the Fair buildings. It marks a distinct growth in the popularization of architecture that not only are the great magazines actively discussing the architectural problems suggested by the Fair, but that the newspaper press is giving some of its valuable space—actually encroaching on the daily supply of murders, rapes, prize-fights, suicides, and base-ball items, and other valuable "news"—for instructing the people on the architectural wonders all the world may see at Chicago. The accomplished lady who composes essays on art subjects for the New York *World*, and

who thus contributes more than her share towards relieving the Sunday issues of that paper from utter sordidness, finding her stock of subjects running out towards the end of the summer, betook herself to Chicago, where she was mightily astounded at the sights she saw. In fact, she has scarcely been able to write of anything since but Chicago and its wonders. Yet it is the Fair that has dazzled her, rather than the architecture of the city of Chicago. As a consistent New Yorker she must find some flaws in the mighty wonder of the West, and peck at and make the most of them. The dwellings of the city came in for this part of her studies, and every reader of the *World* who cares for architecture was speedily given to understand that in the matter of private dwellings, however better she might be in other respects, Chicago was "not in it." This is really very sad, but as it is not to be expected that a New Yorker will become converted to Chicago and its ways in a single visit of three days, it may be hoped that by the time the Fair year comes around the *World's* critic will have evolved sufficiently to recognize the genuine merits of Chicago architecture as a whole. A writer who blindly refuses to understand why so perfect a group of structures as the Fair buildings could have been designed and executed in Chicago is deliberately closing her eyes to things that stare every one in the face. There is no greater nonsense than to pretend surprise at any good in Chicago architecture: one might as well be astonished at the bad things in New York. By the way, Mrs. Van Rensselaer makes a curious slip of the pen in speaking of the "Cathedral of St. Mark's at Venice." St. Mark's never was a cathedral, or, ecclesiastically, anything more important than the chapel of the Doge's Palace. The cathedral of St. Mark's is the unimportant church dedicated to San Pietro di Castello.

THE plans for the new buildings of St. Luke's Hospital, which are to be erected on Morningside Heights, New York, near the new Protestant Episcopal cathedral, have been on exhibition during the past month. Ten sets of drawings are offered in competition from as many architects. In designing a hospital the most important part is, not the external architecture, but the adequacy of the manner in which the buildings fulfil the conditions of the most advanced and improved hospital methods. The value of an imposing structure is not to be denied, but the great question, and in truth the only one, is medical. It is scarcely short of astonishing, therefore, that in an important competition of this kind only one or two of the architects should exhibit sectional drawings showing such an important matter as ventilation, while heating, plumbing, and lighting are apparently left for future consideration. Descriptions of the plans, it is stated, have been prepared for the benefit of the trustees, but the general public has not access to them, and possibly would not understand them if it had. The fact remains, therefore, that the world at large has been invited to inspect a series of architectural drawings, and pass on their merits, while the really fundamental drawings, on which alone intelligent criticism could be made, are not in existence. Generally speaking, the plans as shown exhibit two chief characteristics; they represent buildings with external courts, or with internal courts. Whatever be the relative merits of the designs, the former certainly are superior to the latter in idea. Internal courts give little light and are without the free circulation of air which is essential in sound hospital construction. Mr. Keller's plans are the most faulty in this respect, the perspective showing a large rectangular building with wholly internal courts. Mr. Wood's design, though less compact, also exhibits internal courts, in which the buildings are closely crowded. It is scarcely to be expected, in so important a structure as this, that some external features should not be included. Messrs. Heins & Lafarge show a chapel front, in which they have reproduced the *motif* of their cathedral façade, and which looks better here than in the more pretentious structure. Messrs. Thom, Wilson & Schaarschmidt show an extremely elaborate administrative building, in which the decoration is altogether

out of place. Mr. Lord's design shows a chapel, in which the chief feature is a central lantern, and the whole is very good, with the great merit of not being too elaborate, while possessing sufficient dignity. Other drawings are shown by George E. Harney, with whom is associated Mr. William S. Purdy; Messrs. Sinclair, Doan & Horsfall, Mr. Ernest Flagg, Mr. Henry Rutgers Marshall, and Mr. Charles Alling Gifford. Messrs. Lord, Heins & Lafarge, Harney, and Renwick, Aspinwall & Renwick, were invited by the trustees to prepare plans, for which they will be recompensed. The last-named firm found themselves unable to compete within the time allowed, and withdrew from the competition. The remaining architects competed on a general invitation.

THERE is a valuable and instructive article in the current number of the *Architectural Record* on "New York Flats and French Flats," by Messrs Hubert, Pirsson & Hoddick, who have had an extended experience in flat-building in New York, which may be profitably read by every builder and investor in this form of property in the country. There is probably nothing American architects pride themselves on more than on their ingenuity in planning, and using up every possible inch of space. Our apartment-houses, as well as our office buildings, contain some marvelously compact examples of planning, which are the pride of their creators. The authors of the article under discussion do not hesitate to condemn this system in the most unsparing manner, and the contrast they draw between the plans of French architects and those of America is very much to the advantage of the former. It is true there will be an apparent waste of room in the French flat, judged by current American standards, but when it is remembered that this expansion permits absolute privacy in the apartment, that no two windows look directly into each other, that ample space is given between opposite enclosing walls, and that, finally, the French apartment-house is not crowded to suffocation by squeezing a disproportionate number of families into a given area, it is evident enough that American builders have something yet to learn, and that, important as it may be to extract every penny from every inch of surface, the thing may be overdone. We have no real French flats in this country; we have an architectural monstrosity that is called by this name, but save in nomenclature it bears no resemblance to the genuine article. One great trouble in New York comes from the utter impossibility of building properly-planned flats upon the regulation-sized lots. A plot of ground twenty-five feet wide and a hundred feet deep is not adapted to flat-building. It is much too narrow. Some relief would be had if builders would use more than one lot for such purposes, but even this would not introduce a more liberal system of planning, would not banish the dark room, the most hideous invention of modern architecture, and would not tend to improve privacy were not complete changes made in the plan. The question is not one that is of interest to architects alone, but concerns the general public as well. The sooner people know that there are better forms of dwellings than the present system employed in New York flats the speedier will be the reformation. In the meantime, however, it must remain a matter of regret that, with such excellent models before us as may be found by the thousand in Paris, we should have set ourselves up as infallible, and used miles of building area in following a wholly wrong model of our own.

BOSTON is grappling with the problem of a municipal building, and as a preliminary step has sent a commission to investigate the wonders of municipal architecture with which other American cities are blessed. There is no doubt but that the gentlemen composing this traveling architectural commission enjoyed their excursions hugely, but it may well be doubted if they profited greatly by their trip from an architectural standpoint. As a whole, American cities are notoriously weak in municipal buildings. The conditions under which most of them were built smack so loudly of politics that it is almost impossible to obtain from their inspection any lesson

save what not to do. If the City Fathers of Boston learn this lesson, their architectural junket will not have been in vain. For many years the City Hall of Boston has been much too small, and its enlargement or rebuilding has been agitated at sundry times. The present effort to erect a large addition or an entirely new structure seems to bid fair to succeed, though the minority report of the preliminary committee suggests, in view of forthcoming great expenses and the probably large cost of a new structure, that the work be again postponed until a more convenient season. The City Architect has prepared plans for a new building at an estimated cost of $2,400,000. The commission points out, however, that the cost is more likely to go above this amount than to equal it, and gives $3,500,000 as a more probable figure. This, with the cost of a new site, would bring the total up to about $6,000,000—a nice fat job for the city starvelings to enjoy. All this is almost equivalent to saying that an indefinite amount must be appropriated if the city is to have a new municipal building. And if it wishes one in accordance with the pretensions of the town to superiority and culture, it may be well to admit this at once. The City Hall of Baltimore cost $2,281,135; that of St. Louis $2,000,000; that of Chicago $4,500,000; that of Philadelphia $16,000,000. The Philadelphia building attracts most unwarranted attention by reason of its gigantic size and monumental cost. That Boston will be saved the error of reproducing such an overgrown monstrosity seems evident, for its committee, after a careful examination of the huge pile of brick and marble, solemnly reported that "It is somewhat difficult to decide to what order or style of architecture this magnificent building may be credited."

THE burning of the Metropolitan Opera-House in New York calls attention once more to the fact that theaters are dangerous places, made more so by carelessness or inattention to the plain requirements of safety. The Metropolitan was one of that very numerous class of structures in this country which is pronounced fireproof by competent authorities. To a certain extent this was true, or at least as true as could be affirmed of any structure into which iron enters as an essential part of the construction. Unfortunately, no matter how careful the construction, the materials stored in an opera-house, or in any theater, as a matter of fact, and the necessary kind and amount of work carried on there, render the materials of the building alone but a single part of a very dangerous whole. While the real cause of this fire may never be known, it clearly shows the necessity of completely separating workrooms from the theater proper, and that the risks incurred from storing large quantities of inflammable scenery above and below the stage are extremely great. Another practical lesson which may be drawn from the fire is the urgency of complete preparation for such catastrophes at all times. The asbestos curtain, which is popularly looked upon as a universal protection against fire, was not lowered either before or during the fire. Had this been properly attended to, we should have been able to gage the practical value of this article of theater furniture. Then again, the sprinkling apparatus with which the stage was furnished was either altogether insufficient, or the fire had gained so great a headway by the time the fusible plugs were melted that the volume of water had no effect. This fire brings the number of theaters burned in New York city alone since 1820 up to thirty-seven, though only eight of these have been destroyed since 1876. This, however, is too great a proportion for buildings whose construction calls for the utmost care. While the burning of the Metropolitan doubtless will compel greater care in immediate theater-construction, it is likely to have a deleterious effect in rendering people skeptical as to the value of fireproof construction. If the Metropolitan Opera-House, on which no expense was spared, could suffer so severely, what may be expected from less important houses?

CIVIL ENGINEERING.

Conducted by T. Graham Gribble.

WITH the near approach of winter the fear of an invasion of cholera in its worst epidemic form in the United States is less than it was a month ago. The yellow flag still floats over the great ocean-carriers in New York harbor, however, like the finger of the Angel of Death at the gateway of the country. The innumerable avenues of possible contagion through the Canadian frontier still maintain a constant dread in the northwestern cities. The possibility of dormant cholera continuing through the winter, only to break out in the spring as an endemic rather than an epidemic, is a further cause of uneasiness, especially to the vast interests connected with the coming World's Columbian Exposition. If the United States is preserved from the awful scourge, the present fear will doubtless result in a salutary stimulus to sanitary improvement and general municipal reform. The system of extinguishing fires in this country, so efficient as to be unexcelled throughout the world, has resulted from terrible conflagrations, which have placed this department of municipal business in such a position of primary importance that the citizens will tolerate no tinkering with it. The country will, it is to be hoped, deal with the sanitary problem and its yokefellow, the water-supply question, in as thorough a manner as with the prevention of fire.

This can only be done by the public voice demanding for sanitation and water-supply a position which cannot be undermined by the sins of omission and commission which so beset the municipalities. It will require all the taxation the people can stand to obtain healthy cities without allowing for any leakage of their money through pervious officials. It would be amusing, were it not so serious, to see how the cholera scare has driven some of the great municipalities to raid the filthy purlieus and bring to light all the stinking holes which nobody knew about before, but everybody believed to be kept pure and clean by means of his taxation.

Chicago, for example, now admittedly harbors typhoid fever continuously and increasingly. Immense drainage works have just been commenced, but, apart from the fact that it may be three to five years before they are completed, they do not meet one of the chief dangers of the situation. They leave the Chicago river as a common sewer, and only deal with its fever-breeding effluent after it has traversed the city and been well churned up by propellers. All round the vicinity of the World's Fair the broad flats, mostly swampy, have been for years the dumping-ground for city garbage. The excavations for the elevated-railway approach to the World's Fair are filled during the work by seepage from these flats, and the water is pumped out, blood-red, as if it came from a slaughter-house. The smell is indescribable. As yet the city has gone no farther than to order the construction of an experimental crematory for city refuse. How long it will take to build and how much longer it will take the authorities to decide to abandon their present practice of constructing fever-swamps, it is impossible to say.

The water-supply, both of New York and Chicago, is in an unsatisfactory condition. The presence of nitrates and nitrites in the Croton water prove the inability of the former municipality to preserve the reservoir from defilement. As regards Chicago, Jersey City, Philadelphia, Cincinnati, and most of the other principal cities, the water-supply is derived from notoriously polluted sources. Filtration systems upon an efficient scale are almost unheard of, but Philadelphia talks of putting in a 20,000,000-gallon plant, which doubtless will filter through much municipal machinery before it is built.

The chief sin of municipalities is not that they are slow, inefficient, and wasteful; it is that they employ so many political hangers-on instead of the best professional talent at their command. Saloon-keepers cannot be expected to be masters of engineering science, but, having in their hands literally the power of life or death to the citizens, they might at least employ men who understand their business and give them a fair show.

The *Engineering News* some time ago gave sensible advice to a correspondent who was raising an outcry against a flagrant case of injustice to a well-tried and capable municipal engineer who had been ousted from his position. The reason of this dismissal was not even that he had dissented from some of the unprofessional rulers of the Council. It was because he failed to recognize one of the occult wire-pullers of the municipal machine, one of the powers of darkness behind the civic chair. The *Engineering News* simply advised its correspondent to look upon a municipal appointment as the very last thing to take up, if he could possibly get anything else within the entire range of engineering practice. Until the public alters this state of things, improvement will not advance very rapidly.

AT the coming World's Columbian Exposition, the public will have an opportunity of examining one of the most interesting systems of transportation, the *chemin de fer glissant*, or sliding railway. The writer, having traveled on it at the Edinburgh exposition, can testify that it is hardly possible to say, without looking at the receding landscape, at what rate the train is moving. A speed of 100 miles per hour would produce less sensation of movement than twenty miles per hour on an ordinary train. It is to the railway car what sleigh-riding is to a cab-drive. The peculiar feature about the system is that, although forty years old, it is still commonly regarded as a toy, and with all the advertisement which it has had at the great expositions of the world, it has not yet been introduced into competition with other means of intramural transportation.

Sir Douglas Galton read a paper upon the subject before the Society of Arts in London two years ago, from which is taken the description which follows. Forty years ago, M. Girard, the eminent French hydraulic engineer, conceived the idea of a hydraulic railway in which the locomotive should be replaced by a series of jets of water issuing from nozzles standing up along the center of the track, so arranged that the issuing streams could exert their effect on the under side of the carriages composing the train and cause it to travel along the rails. He further proposed to suppress the wheels and substitute flat surfaces or bearing plates, upon which the carriages would rest; these would slide upon rails of a section specially designed to support them, and in order to reduce the friction M. Girard proposed to separate the surface of the rail from that of the bearer by means of a film of water to be maintained between the bearing plates and the rails. M. Girard obtained from Napoleon III. a concession for a railway upon this system clear across France, which was granted to him, together with a government subvention, in 1869. The Franco-Prussian war intervened; the German army destroyed M. Girard's model railway, and the inventor himself died on the field of battle. After peace was restored, M. A. Barre, who had worked with M. Girard, purchased all the documents relating to the railway, and has since been engaged in making further experiments upon and gradually changing and developing the original ideas of M. Girard.

The design may be classed under two heads:

First, the arrangements for supporting the vehicle: (1) the bearer or skate affixed to the vehicle; (2) the method of supplying the film of water to the bearer or skate; and (3) the rail.

Secondly, the method of propulsion intended to supersede the ordinary methods of traction. This consists of (4) the arrangements on the vehicle for receiving the water of propulsion; (5) the hydrant for propulsion; and (6) the arrangements for catching the water after it has served its purpose.

Since the detailed explanation of the system would involve the introduction of illustrations, we will confine ourselves to a general statement of our views as to the adaptability of this system; or, rather, one feature of it,—intramural transportation on this continent. The points of advantage claimed by M. Barre for his system as a whole are:

1. Smoothness of motion: that is to say, absolute freedom from vibration or jarring and absence of dust.

2. Absence of noise and smoke.

3. Small risk of running off the line, because no object, however small, can pass under the skates.

4. Power of stopping almost instantaneously, very smoothly, and without any shocks; diminishing chances of collision from meeting trains; power of stopping on a gradient as steep as 45 in 100.

5. Ease in ascending inclines, and in traversing curves with a radius as small as 132 feet.

6. Power of attaining a speed of 100 miles per hour on the level if the pressure on the water main be increased to a little over 300 pounds per square inch.

7. Remarkable lightness of the cars, which would not weigh more than half as much as those of ordinary railways; absence of heavy locomotives and tenders; and consequent lightness of bridges and other works of construction.

8. Almost entire saving in cost of traction in mountainous countries in which there are large waterfalls, and very large saving in cost of traction even where all the water has to be pumped.

9. Economy in train expenses resulting from the abolition of greasing and from the saving of repairs of wheels, axles, grease boxes, and brake apparatus.

10. Large saving on the maintenance of the steam-engine; first, because there would be less horse-power to do a given work; secondly, because the fixed engines which pump the water would be worked under conditions more favorable for economy than is possible with locomotive engines.

With regard to the application of the sliding railway to trunk lines we have nothing to say. The system is radically different, and its introduction would be a foreign element in an international system with which it could have no fellowship. In its bearing upon the question of intramural transportation the case is different. The method of supporting the vehicle, with its consequent smooth and noiseless motion, is, as far as we are aware, the only device which actually obtains one of the essential elements of success in an elevated urban railway.

Given a noiseless, smokeless motor running on an ornamental structure in the middle of a wide avenue, and all reasonable objection to elevated roads is removed.

The method of propulsion by water jets is not essential to the system; neither do we suggest it for general adoption. The hydraulic propulsion involves a great expense of installation; it requires very careful attention both to the hydrants for propelling the train, and to the appliances for catching the waste water and conveying it back to the various pumping stations. The sliding gear, on the other hand, is comparatively simple, the quantity of water required is small, and the waste water could easily be kept from leaking into the streets.

Not being furnished with wheels, the sliding railway is only suited for cable traction if the hydraulic propulsion be dispensed with. No other motive power, such as electricity, steam, or compressed air, would be applicable. Cable traction, however, upon an elevated structure, has been shown in the case of the Brooklyn bridge to be exceedingly economical. Mr. T. C. Clarke made a comparison of the relative cost of traction upon the Manhattan railway and the Brooklyn bridge, and found an economy in the latter of 45 per cent. per passenger-mile and of 24.2 per cent. per train-mile. These figures covered the total cost of operation; the comparisons for motive power alone were very much more in favor of the cable. The cable is also adapted to very high speeds, which, not being practicable upon surface railways, have not as yet called forth the suitable grip-car. Messrs. Pendleton & Bryson, of

New York city, have patented, however, what they term the "extended grip" motor, which appears to be a safe and efficient means of hauling heavy trains at high speed. Although it has not been tested to any great extent, it serves to prove that the thing is perfectly feasible. The water-skate of the sliding railway furnishes in itself a most powerful brake, for by shutting off the water from the rail the skate becomes a "track-brake" which will bring the train to a standstill on the steepest gradient.

IN our brief notice last month of the proposed Chesapeake and Delaware Bay ship-canal, we were unable to give space to details of this interesting and important project. Professor L. M. Haupt, of the University of Pennsylvania, has thrown the weight of his professional reputation into the furtherance of the scheme and has made a survey and report upon it. The most cursory study of the map of the Maryland peninsula will exhibit the great advantage of a short cut from Philadelphia to Baltimore, and the magnitude of the coasting traffic is known to all. The existing canal is one of the ancient boat canals of 9-foot draught for which a company was incorporated in the year 1799. The succeeding railway development threw it, like all the other old canals, into the background, but it is now before the public again as a case for an enlarged waterway of relatively as great importance as when it was created in its present form. The railway system has nowhere superseded the canal by reason of the inferiority of the latter as a means of transportation in bulk, but in most cases the canal has been incapable of development on account of the difficulty presented by the locks to an enlargement corresponding with the growth of ship-building. It would appear that the Chesapeake and Delaware canal is exceptionally free from this difficulty, and that the existing locks with the exception of that at Delaware City only require to be removed, leaving the rest of the canal unobstructed.

The summit level is nine miles long and ten feet above tide water. For a distance of about three miles on this level, the canal passes through hills of sand and clay about 76 feet high. About 3,500,000 cubic yards were excavated in building this section. The tide at Baltimore varies so slightly that a tidal lock at the Chesapeake end would not be required. In 1883, when the agitation for a ship-canal across the Maryland-Delaware peninsula was at its height, a survey was made by the United States Corps of Engineers for a waterway 100 feet wide at the bottom, 27 feet draught, and a slope of ½ to 1. The estimate, including tidelock, railway, and other bridges, amounted to $4,355,807.

In Professor Haupt's opinion, a narrower channel would cost much less and fulfill all requirements for years to come, and he makes an estimate for improving the canal to a bottom width of 50 feet, 27 feet draught, 131 feet top width, with the one tidal lock, as follows: Dredging, $1,512,259; auxiliaries, $631,500; contingencies, $214,376; total, $2,358,135. The canal so improved would give a route from Baltimore to Philadelphia 112 miles long. The route around the peninsula is now 422 miles, and the consequent advantage to Baltimore would be a saving of 310 miles each way in the route of the grain carriers to the sea.

Professor Haupt says:

> The revenue to the canal would be that resulting from nearly the entire foreign commerce of Baltimore, as well as a large part of the coastwise trade between Baltimore, Philadelphia, New York, and Boston. Between Baltimore and the sea there would be saved about 190 miles each way, or 380 miles for the round trip. As the cost of movement for a 3000-ton vessel is about $300 per day, if its distance covered is 250 miles in twenty-four hours, then the cost of a tow-mile is but four-tenths of a mill, or about one-tenth of the lowest railroad rates. Hence it is beyond railroad competition, and if such freight boat can save 380 miles, or 36 hours of time, it can readily afford to pay 10 cents each way upon its gross tonnage. For coastwise traffic between Philadelphia and Baltimore the distance saved by the canal would be 310 miles each way, while the rate on the lighter-draught steam vessels is higher; hence if the schedule rate were 20 cents per trip per ton, which is lower than the present charges, it would stimulate this commerce and increase the income of the canal. The existing

commerce of the Delaware and Chesapeake Bay exceeds 27,000,000 tons. If only 5,000,000—less than 20 per cent.—used the canal at an average rate of 15 cents, it would produce $750,000, or 30 per cent. on the $2,500,000 required to enlarge the channel. On the total capital, including the present indebtedness of $4,000,000, it would pay not less than 12 per cent., instead of 5 per cent. on $2,600,000 as at present. The canal so improved would prove of great value to the government in the event of war, and could be made to form a part of a general internal waterway system extending from Cape Cod to Florida.

Mr. Joseph Gillingham, of Philadelphia, president of the canal company, is in favor of the project, and it is expected that the canal directory will also indorse it. It is proposed to form a company of New York, Philadelphia, and Baltimore capitalists to push the enterprise. Senator Higgins, of Delaware, is looking into the matter, and it is said that Senator Gorman is also interested.

THE question of filling in the Harlem river is being brought prominently before the public. The report of a board of engineers to the Senate Committee on Commerce adduced evidence to the effect that such filling in would create 235 acres of land, or 3762 city lots, worth about $10,000,000, and it was claimed that an addition to the value of real estate on both sides of the Harlem would be made, amounting to $100,000,000. The Government works in deepening the channel so as to make a navigable waterway for large vessels from the Sound to the Hudson river would under this project be rendered valueless and be added to the list of charges of worthless Government engineering made by civilians. Naturally the Government is not prejudiced in favor of the scheme, and it is another instance of the necessity for more complete accord between the Federal department of public works and the wants of the public.

THE Chicago Sanitary Commission is proceeding rapidly with its gigantic undertaking. The work already let to contractors lies between Willow Springs (a village some fifteen miles to the southwest of the center of the city) and Lockport (near Joliet in the same direction). This work, which is largely in rock, represents the most expensive portion of actual construction, but the entrance into and passage through the city will be most costly in damages. The right of way from Willow Springs to Lockport consists of 3300 acres, which have all been acquired, making a total distance of fourteen miles. The commission has now decided upon the route for the entrance into the city after consideration of five alternative lines. The present design is to admit water from the lake of sufficient volume to dilute the city sewage and carry it into the Illinois river without pumping. The same intention was the origin of the Bridgeport pumping-works, which under ordinary circumstances divert the flow of the Chicago river into the Illinois and Michigan canal and thence into the Mississippi. In floods, however, the water of the Desplaines and Chicago rivers finds its way in great volume into the lake, forming a sewage-flushing system on a large scale but in the wrong direction, and to the great detriment of the water-supply. The Desplaines river and the Illinois and Michigan canal run parallel from Summit to Willow Springs, a distance of about six miles, and the question before the commission was whether to utilize either of these water-ways for the new channel. Regarding this line, the report says in brief:

It is considered that the work will be facilitated by obtaining a location that is entirely free from the Desplaines river and the Illinois and Michigan canal. This necessitates a shifting of the bed of the river to the westward between Willow Springs and the Calumet Terminal Railway, and a similar shift above the Summit road and embankments along the corrected river from the high ground below Riverside to Willow Springs. The course of the new stream will be through marsh and at the foot of the high ground on the west, so no unusual difficulties are presented. The main channel is therefore restricted to the narrow area which may be thus freed from water, lying between the canal and the river as corrected. It is at a fixed distance from the canal for the greater part of the distance. The proposed treatment of the river enables a certain restraint of the flood waters of the Des-

plaines without material expense to the district. The situation at Joliet will not permit an increase in maximum flood volume; neither can this maximum be increased through twenty miles of the Desplaines valley and adjacent to the work on the main channel without a large increase in expenditure. All flood waters, however, up to this maximum may be constrained to the south. Under present circumstances the volume going down the Desplaines river does not exceed 60,000 cubic feet a minute before it begins to spill over the Ogden-Wentworth Dam and through the ditch of the same name to the west fork and thence through the Chicago river to the lake, *taking in its course the sewage of the city.* Under the proposed conditions the volume may reach nearly or quite 400,000 cubic feet before any of the flood need come toward Chicago. In a series of years, the number of days of floods in excess of 400,000 cubic feet is so small as compared to the number in excess of 60,000 cubic feet that a radical change may be thus effected in respect to the flood waters from the Desplaines. The value of this work, pending the completion of the main outlet of the district, cannot be gainsaid, especially as a series of rainy seasons may be anticipated after the several years of extraordinary dry weather, and the general sanitary condition is not reassuring. Your committee, therefore, urges that the work between Willow Springs and Summit be put under way at the very earliest practicable date, with a view of securing all needful correction of the river before next spring.

The report bears the stamp of Trustee Cooley's literary talent and painstaking analysis. Five alternative routes are discussed, and the reasons for the one selected given at length. There has not been any wide difference of opinion in the Council chamber, although the details have provoked considerable discussion. This diversion of the river Desplaines, if undertaken in dry weather, will not be a difficult matter, because it is then nothing more than a stream two or three feet in depth, overlying the limestone rock formation which supplies Chicago with building stone. It cannot be said that the entire scheme is free from criticism, or, at least, that it is the only possible solution of the present problem, but it has been elaborately developed and has received the indorsement of the best engineers. The floodwaters of the Desplaines river are estimated at 400,000 cubic feet per minute. The flushing channel from the lake now to be constructed will have a capacity of 600,000 cubic feet, and will be needed to dilute the sewage on its way to the Illinois river. At present the floods of the Desplaines river are accompanied by much injury to the bottom lands of the Illinois river, but a great portion of the flow comes out into the lake in the manner described by the report. When the whole flow is constrained to its natural channel, and flushing waters for the sewage are added thereto, it is difficult to estimate what the increase of injury will be. The admission of lake water for flushing will of course be regulated but this regulation will be a somewhat difficult matter. Under the present system of water-supply from tunnels run square out into the lake, it is of course all important to diminish the chance of contamination, but it is open to question whether even the four-mile tunnel will be all the city will require. It has been proposed in lieu of these works to lay pipe-lines along the foreshore northwards to an intake about forty miles distant. The set of the current is southward, and the supply for the southern districts of the city is now in worse condition than the northern because the river mouth and lake front are continually furnishing pollution traveling southwards.

Another moot point is whether the sewage will under the new system pass freely to the flushing-point, or whether it will not leave the river in its present condition of an open and offensive sewer. In the latter case Chicago will have to prepare herself for a complete treatment of the sewage question without making a convenience of the river.

THE manufacture of nickel steel for armor is being extended. A new steel made in France at the Creusot works of MM. Schneider, containing 2 to 4 per cent. copper, is said to have great resisting strength, elasticity, and malleability combined.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

SPECULATION in mining stocks has been steadily dwindling for years. Formerly there were dull times as well as times of excitement, but after each period of depression there was always a reaction. Latterly, however, there has been a monotonous inertness, so long continued without any symptom of renewed activity that it looks very much as if the stage of coma had nearly merged into that of dissolution. Is mining-share speculation then really dead, like the South-sea bubble, the Mississippi scheme, the tulip craze, the Gold-room fever, or the Panama-canal boom? It is not safe to say so. There are no present signs of resuscitation, and the prevailing tone of public sentiment is such that nothing short of a second Comstock (or a widespread belief in one) would galvanize the seeming corpse into fresh life—just now. But human nature is a queer thing,—subject to sudden superficial changes, wearying of one form of excitement and seeking a new one, jumping from unthinking credulity to ultra-conservatism, at one time only too anxious to be humbugged and at another too timid to pick up a gold brick,—and in the long run it shows itself the same as ever. If mining were like any of the other exciting causes referred to, a merely temporary, sporadic incident, it would be easy to understand why it might drop out of sight as a basis for speculation. But it is not. It is a permanent factor, like real estate or such merchandise as grain, petroleum, or cotton. Shares of mining companies are like those of railroads, among the most convenient vehicles of gambling. So long as the gambling instinct remains, as it certainly does despite periodic suppression, it is bound to revive, and it will naturally return to the most promising fields. Mining is really just as "legitimate" a business as any other, and some branches of it can be conducted with as much foresight and steadiness as manufacturing or transportation or agriculture. Yet the element of chance cannot be denied, and to the popular mind it is still exaggerated. The public is better informed now about the true conditions of mining, its education having been gained by dint of costly experience. But let the public rest long enough, or give it time for a new crop of innocents to come up, and history will repeat itself. As to those who have paid for their experience, it may be said that a burnt child shuns the fire; but some burnt children have a happy faculty of forgetting after their scorchings no longer tingle, while there are always any number of unburnt children ready to experiment for themselves.

IT would have been hard to make any one who was watching the San Francisco Mining Stock Exchange in the "seventies" believe that as early as 1892 the members would be talking of selling their $700,000 building for $450,000 and going out of business. Yet such is really the case. The brokers evidently have made up their minds that the game is up. And now, if any one ventures to predict that there may be a turn in the other direction, the assertion seems foolish. Only those who were in California and Nevada during the several periods of excitement can realize to what a pitch that excitement went. San Francisco was trying to do a business of two or three hundred millions on a cash circulation of ten or fifteen; there were three separate exchanges in full blast, to say nothing of the curbstone traffic; a mine like the Ophir might change hands in a single session; every barber and merchant, chambermaid and schoolma'am, waiter and parson, hod-carrier and book-agent, had shares and was seeking diligently for inside information, even turning to the clairvoyants and

mediums for pointers on stocks. Perhaps such furores may never recur. But they may.

MINING EXCHANGES on a small scale have been in existence in many other cities, as at St. Louis, Salt Lake City, Denver, and Aspen, none of which are in a flourishing condition. That at Denver was founded on a naïve combined Sunday school-faro bank idea, which naturally did not work smoothly; and it, as well as the other infant exchanges, is now in straits. In New York there is the Consolidated Exchange, which cannot be accused of having been over-fastidious in its listing; and the regular Stock Exchange, which treats mining stocks precisely as other securities, and has a fairly respectable list, including some of the best dividend-paying ones. Boston deals mostly in copper stocks; Philadelphia in coal and iron stocks, etc. Many mining stocks—Cornish, Australian, Indian, Transvaal, and American—are also quoted in London. In none of these places is there any extensive trading in mining shares at present.

SHARE speculation, on the whole, has hurt mining. It has created a prejudice in some minds against the industry as being more uncertain than it really is. It has caused a great deal of unprofitable and sometimes hopeless work to be carried on by assessments, for not a few mines have been kept going simply for the sake of the stock market, with no other claim to maintenance. Speculation has also involved some very crooked methods, which have reacted adversely to mining. But it has done considerable good withal, which it is unfair to ignore. It has helped to develop some good mines which would not have been worked otherwise, and has at least kept the industry prominently before the public in times when it would have been difficult to attract capital in any other way. Altogether, the good has not offset the harm; but there is no sense, in these days, in holding up one's hands in an assumption of puritanic holiness and declaiming against speculation. If men must gamble, they might as well do so in mining shares as in anything else, provided the methods are equally fair. And, to put it frankly, it is certain that from an ethical point of view a straight-out gamble in mining shares is immeasurably preferable to the meaner phase that has for the time supplanted it, the modern hypocritical mock "investment" scheme, where the investment is truly a permanent one, a literal sinking fund.

THE success of the process of solidifying petroleum by the Clenhall method appears to have been demonstrated, and also the greater calorific properties of the block petroleum over good steam-coal. The process of manufacture consists in exposing the liquid petroleum, mixed with certain ingredients (the nature of which is not stated in the published reports), first to a moderate heat, and subsequently to a higher temperature, until the chemical action on which the process is founded is completed, the operation requiring about an hour. The product, while still in a semi-solid condition, is then molded into blocks under pressure. No data are given as to cost, but the process is said to be very simple, requiring no special skill, and the "ingredients" are described as ordinary articles of commerce. On a trial conducted by the company manufacturing the new fuel 66 pounds of the petroleum blocks raised 80 gallons of water to a steam pressure of 60 pounds in 36¼ minutes; while it took 106 pounds of the best steam-coal 60 minutes to do the same work in the same boiler. The new fuel is said to be nearly smokeless when fairly ignited. Unquestionably any process of utilizing petroleum as a steam-fuel which would not demand sprayers or other apparatus, and special boilers, would have great advantages, if not too costly. It would also simplify methods of transporting petroleum under conditions where the pipe- and tank-systems are objectionable.

MR. CARL HEINRICH'S timely paper (in the *Engineering and Mining Journal*) on the wasteful methods of zinc-blende mining in southwest Missouri, with suggestions as to the rational way of working

these lenticular deposits in limestone, would apply to mining in similar formations elsewhere. In the Missouri mines the drainage shafts do not unwater the deposits to the bottom, and the lessees work out the upper drained part of the ore body, without timbering; and if ore pillars were left during the stoping, these are robbed, and the empty chamber thus left finally caves, rendering the lower part of the ore body inaccessible. Mr. Heinrich points out that the correct and ultimately more economical method would be to sink the trial or drainage shafts a fair distance below the bottom so as to drain the whole of the deposit, which is opened by drifts at various levels from the discovery shaft. A second smaller shaft should then be sunk near the center of the ore body. Mining should begin at the bottom and extend upward in an arch form so that the roof may partly support itself. Square sets of timber would give access to the face; the barren rock would not need to be raised out of the mine, but would be used as filling; while the tailings from the concentration works could be sent down the air shaft as an additional filling. In this way the whole ore body could be excavated, without danger of caving; and the tailings dumps, instead of bearing down on the limestone roof, would be done away with. In short, Mr. Heinrich's plan follows the recognized principle that the overhead system of stoping is almost always preferable to the underhand system.

IRON-MATTE smelting is growing in favor. In its latest form, it is really a concentration process, by which a greater part of the precious-metal contents of low-grade pyritous ores is concentrated in a product available for shipment and final reduction by the ordinary lead-smelting water-jacket furnace. As now practised at Leadville, it is claimed that from five to ten tons of such ore can be concentrated to one ton of matte, with a saving of not less than 90 per cent. of the silver; and that the cost is only about $2.50 per ton, since little fuel is needed besides the sulphur contained in the ore. On this basis it is calculated that 12-ounce sulphids can be handled with a fair margin of profit. The new method, known as the Austin process, is an outgrowth of the sintering or agglomerating process in reverberatories, long used both in this country and in Germany, but differs from the older method by aiming directly at concentration, and not merely in producing a better furnace material (partly matte and partly fused ore) by burning off part of the sulphur. By making concentration the principal object, it is manifestly better to place the matting furnaces near the supplying mines; then, after obtaining the concentrated matte in this way, it can be shipped to the most available market, which may be a smelting center at some distance. The plan may be adopted in conjunction with wet concentration, or for some ores may encroach upon or supplant the latter. In either case it promises to benefit districts producing low-grade pyritous ores, where complete lead-smelting cannot be done to the best advantage.

IN connection with the discussion of machine mining in a previous number of this magazine, Mr. William L. Saunders communicates a description of his proposed system of driving tunnels in solid rock, which presents some novel features. The methods previously suggested for expediting this work adhered to the idea of cutting out a channel around the whole perimeter of the face, and, if necessary, blasting outwardly from the center of the standing block thus formed. Mr. Saunders's plan involves no departure from the accepted principle of blasting toward the center, though entirely differing in details, and requires much less channeling than would be necessary in blasting outwardly from the center. The usual method comprises the drilling of converging holes about the center line of the heading and of a number of other holes at suitable intervals. The converging holes are fired first, throwing out a wedge-shaped mass between them and thus forming a release or line of least resistance for the action of the explosive in the side holes. These latter are then fired, breaking out the intervening rock to the depth of the cut produced by

the first blast. The innovation consists in making an artificial channel, straight and deep, instead of blasting out a center chip. The converging central holes are dispensed with; and in their place, by means of a modified bar channeler, a deep cut is formed. The machine with which this is done is a combined channeling and gadding machine resembling that successfully used in quarrying, capable of radial or vertical movement and pivoted on a supporting column. It first acts as a reciprocating drill to put in holes of the desired depth at the extremities of the proposed channel. After the end holes have been drilled, the drill-chuck is removed and a cross-head and gang of chisels are attached to the piston-rod, and the tool is caused to travel back and forth between the end holes, cutting a channel of say an inch and a half in width, six feet in depth, and of rectangular or triangular shape, extending substantially from top to bottom of the heading, or from side to side. The cut is made along a center line if there is room on both sides for machine drills to put in the sets of side (or top and bottom) holes at the same time; but in very small headings the channel would be cut along one side, leaving room for the drills to work on the other, placing two rows of holes between the channel and the opposite side of the heading, or toward the roof if a bottom cut is made, somewhat as in undercutting coal. The new system is not to be confounded, however with the practice of breaking down coal In this case the row of holes nearest the channel would be fired first, after which the remaining ones could be fired with the certainty that they will produce the maximum effect on account of the release afforded by the explosion of the first line of holes. But wherever practicable all the shots would be fired simultaneously. The system aims at drilling much deeper holes and fewer of them, using heavier charges, and therefore penetrating farther in a given time with the limited force of men and machinery that can be accommodated in a heading. Mr. Saunders has worked out the details of his method with great ingenuity. He writes that "the system is not entirely a matter of theory. No tunnel has been actually driven by it, though the bar channeler, which is largely used in quarries of all kinds of stone, is doing almost exactly what is proposed in this case. It puts in two holes in the regular way, and then by a simple and rapid change it carries a gang of chisels and makes an open cut between the holes." The method is applicable to shaft-sinking as well as to horizontal workings.

AN old miner, who is now a decidedly practical one (to use the cant phrase), though he began as an amateur fresh from a technical school where at least one detail of his education had been seemingly neglected, gives an amusing account of his early experience in blasting. He and two partners took up a gold-quartz claim in Arizona many years ago, and worked it themselves. None of them had tried this sort of labor before, and there was nobody at hand to give them points. They found pounding a drill to be rather serious exercise, to say nothing of the sore palms, mashed fingers, and bruised wrists that were the regular thing at first. Tender hands of course go with "tenderfeet." They were drifting in a large body of quartz, very hard where solid, but presenting many tempting seams, in which they soon made the brilliant discovery that it was a "picnic" to make an apology for a drill hole. This very natural inspiration has doubtless struck many other beginners. It is plausible, but delusive. Our friends made a great record for fast drilling,—also for blown-out shots. Later they learned from their powder bills that it paid better to take a little more time with the holes and get some results. Natural seams and cleavage planes running lengthwise with the course of a working are a great help if rightly dealt with. They should be blasted toward, not in.

ANY improvement that will save time in driving long mining adits will be heartily welcomed. Indeed the time element is so pressing in many cases that if no economy were gained in other respects, or even if a more rapid system should be slightly more costly, it would be approved where the de-

mand for speed outweighed the difference in expense. In railroad work the tunneling goes on simultaneously with bridge-building, making cuts and fills, track-laying, and the preparation of equipment, and it is only when very long or especially difficult railway tunnels have to be driven that this part of the work is behindhand; while it is often possible to expedite matters by sinking intermediate shafts and pushing several headings at once, which can seldom be done for the mining adits. At a mine sometimes the whole enterprise is at a standstill pending the completion of a drainage adit or the making of a long connection. Latterly there has been quite a decided reaction in favor of opening and working mines by adits in preference to shafts wherever the topography and the lie of the deposits permit. With precious-metal mines the surface contours are usually steep and the veins often dip at high angles, so that crosscut adits even from the foot-wall side are not of necessity disproportionately long as compared with shafts to open a mine to a given depth; while if they enter from the hanging-wall side or follow the strike of the vein, the conditions are of course more favorable. The limit for opening by adits is evidently the depth that can be attained without making them inordinately long; whereas shaft-sinking opens a mine to an indefinite depth, certainly to over 4000, probably to 5000, and perhaps to 6000 feet vertically with present methods and machinery, provided there is not too much water. Thus far only a little beyond 3000 feet vertically has been reached, but much greater depths are known to be practicable and may be confidently anticipated. The self-draining adit has great advantages over a shaft where continuous heavy pumping is required; and sometimes the shaft mines have had to resort to a drain tunnel after all, as at the Ontario, and as may perhaps happen on a much larger scale in the new ore-bearing territory of the Leadville district. An adit may be useful even when it does not tap a mine at the lowest point of the workings, by relieving the pumps and by allowing winzes to be sunk from its level by electric or compressed-air power. Bedded deposits lying at rather flat angles near the surface also are conveniently opened by adits. The power drills —now so much more generally used than formerly— have rendered the driving of long adits less of a bugbear; and, further, there is a growing tendency to plan development of a more permanent character, intended to be effective for considerable periods in the future, and consequently causing engineers to take into closer consideration the running expenses to be met after the completion of the main openings and perhaps to be carried during extended terms of years, when the annual saving in expense of pumping would go far toward extinguishing a difference in first cost if that were against the adit. Not so long ago the feeling was rather the other way, at least in this country. Comstock practice was so far in advance in point of machinery, daring conceptions, haste to get down, and abundant financial support, as to exercise a dominating influence on current opinion, while the bitter war between the deep shaft mines and the Sutro tunnel infused an element of prejudice; so that it was not uncommon to hear mining men who ought to have known better say that they would rather hoist a thousand feet than wheel out double or even the same distance, leaving the pumping altogether out of the question. Experience and reflection have changed all that, and the old German idea of great adits is coming into favor again. No general rule can be formulated as to what length is permissible in ratio to depth, for each case brings in peculiar conditions of its own and has to be judged by itself; and the question is further complicated by the desirability or necessity of having two means of egress from a mine and the requirements of ventilation, which might render it advisable to adopt both shaft and adit.

A PROPOSITION less radical than that of burying the petroleum tanks has been suggested, which might prove effective in preventing the spread of oil fires, if carried out with thoroughness, and which seems to offer a cheaper alternative in some situations and would not call for

the pulling down of the high tanks now standing. It is to build dikes around the tanks, making their height about a quarter of their base, and inclosing an area four times or over that of the base of the inclosed tanks. In cities the cost of ground space might be prohibitive; but in the oil regions the tanks are often built in narrow valleys and depressions where dikes completely encircling them would not be needed, but merely short dams below the sites of the tanks.

IT is now possible to send down a vertical drill-hole to a depth of considerably over a mile. There are several bore-holes of over 4000 feet, but the greatest in the world is that at Schladebach, in Prussia, which in 1886 reached a depth of 5736 feet, having occupied 1247 working days, the average daily advance being 4 feet 7 inches. It cost $53,075, or $9.25 per foot. Work was begun by driving an 11-inch tube through the upper 60 feet of sand, gravel, and marl to the solid sandstone. This was attacked by a drop drill, like that used in our artesian-, oil-, gas-, and brine-wells, having a cast-steel bit in the form of a cross, with tubular rods, water flowing down outside of the rods and rising up through them. At 570 feet a diamond core-drill was substituted, having an 8¼-inch bit and giving a core of nearly 6 inches diameter. Serious accidents and difficulties were met in drilling the first 3510 feet, the rods bending and having to be lifted, a crown sticking in the bottom of the hole and requiring to be ground up by the drop drill, or a tool falling into the hole and necessitating cutting the rods at great depth. Down to this point the diameter of the bore had been reduced seven times, beginning with eleven inches. From 3510 to 5658 feet the hole was continued with a diameter of two inches, giving a core of less than one inch diameter. Strata of gypsum and anhydrite and a seam of low-grade copper schist were encountered, but no coal had been found on reaching the Devonian rocks; nevertheless drilling was continued, with a purely scientific object, the last section being bored with a 1¼-inch bit, giving cores of only half an inch diameter. Finally the difficulties became so great that work was discontinued at 5736 feet. The rocks penetrated were mainly sandstones and limestones, and the hole was cased throughout.

BORE-HOLES sunk from the lower levels of mines are seldom driven very deeply. Usually they explore ground only two or three hundred feet beyond the depth reached by the regular workings. If, however, sufficient motive existed to warrant the trouble and expense, it would be possible to tap a very much greater depth than has yet been reached, by combining a very deep shaft and a very deep bore-hole. By cutting out a chamber just above the sump, of sufficient size to admit convenient handling of the upper apparatus, a large diamond drill plant could be put in, to be driven by electricity or compressed air from the surface. Starting with the advantage of say the 3000 feet already reached by the shaft, the drill might penetrate 5000 feet or more further, or over 8000 feet from the surface. This is perfectly feasible with present means. It is merely a question of time and money, and whether the experiment would be worth while. The disadvantages of working the drill from the depth named can be met, as in lesser drilling undertakings now caried on underground. It follows that, since shaft sinking can be extended to 4000, probably 5000, and possibly 6000 feet, without great modification of existing methods, and since beginning at either of these depths 5000 or 6000 feet more can be gained by drilling, a total depth of 11,000 or 12,000 feet is attainable. This at present is an idle speculation, but it is no wild stretch of imagination to assume that it will be carried into effect whenever the incentive is strong enough.

THE New Zealand government has offered a bonus of $5 per ton for the production of the first 500 tons of marketable pig iron produced from native ores. It must be manufactured from magnetic or titaniferous iron ore, all material, fuel, and fluxes being the produce of New Zealand.

MACHINE-SHOP NOTES.

Conducted by Albert D. Pentz.

THE mixing of mechanics from the different European races in machine manufacture has had an important effect on the development of the arts in America. The British workman brings all the wonderful practice, the arts, and the honest execution of the birthplace of engineering. The Frenchman, especially the Swiss-Frenchman, gives us the refined arts and practices. The German may not have had a refined practice or a smooth execution, but his technical education generally is sounder than the others. The Scandinavian—that Yankee from Europe—either fits every place he falls into or pulls the hole about him. Each nationality brings its native arts and practices. The American finds in a French practice the germ of an invention. The Frenchman finds the missing link of an incomplete chain of discovery in an Englishman's tool-chest. The Englishman finds in the German's mathematics the proof of his speculations. And the German compiles from all and produces a masterpiece. Leaving out invention in the highest sense, there is enough to be gained by the association of the differing practices of the various European nations to produce and stimulate progress for a generation. Then we may begin on those of Asia.

THE effects of expansion by heat dictate that the thrust-collars on machine-spindles shall be near the operative end, as near the center of a lathe and as near the cutters on a milling-machine as practicable. I am old-fashioned enough to prefer collars that embrace the front bearing, the outer one to be a solid part of the spindle, the opposing one to be adjustable on a screw cut on the spindle. Experience shows that within bearings of this kind, where the spindle is of the same material as its bearing, these two parts will expand and contract equally, indicating that heat is perfectly conducted across the joint while the spindle is in motion.

AN adjustable thrust-collar, which is also a clamp-nut, must fit the spindle perfectly before it is clamped; otherwise the truth of its face will be affected by the pitch of the screw within it. It makes little difference how it is clamped; this effect will still appear. If the collar be split radially and is clamped by a chordal screw, its face, in contracting on a screw smaller than its bore, will become a helix, having a pitch proportionate to as much of the pitch of the screw as the collar contracts upon. If possible these thrust-collars should be ground on their own spindles.

BLUNT, who was going away, decided to place De Gree in the pilot-house during his absence. At the same time he made arrangements to have the works steered by a tiller, if necessary. First he called in the traveling man and factotum, Charley Gaul, who has been with him since he was a boy, and told him just how things were to be.

"Give him all the assistance you can; if you see a grave mistake being made, labor with him. The man has more ability and push than most men. He is industrious, and when his rashness is toned down to enterprise he will be of great assistance to us. He is going to get along in the shop, but it is at the commercial end that he is lame, and there you must help him. Don't meddle in the shop or go prowling about in it; the foremen know their duties."

"Where shall I address you in case—"

"Don't address me if you can help it. I will write Mr. De Gree when there is anything to be said and I expect to hear from him. Don't you badger him; help him! Send De Gree here . . . . Mr. De Gree, next Saturday I shall start West on

private business. I shall be gone several weeks, probably, and the works will be in your sole charge. You have four days to look about and see whether there is anything you would like to consult with me about in relation to the business or work to be done in my absence. I presume, however, that nothing will occur which you cannot handle alone, and I shall be gratified on my return to find that you have steered straight, as I have confidence you will."

"I shall do the best I am able to, Mr. Blunt."

"I know you will, sir. But you had better take hold at once—this moment—so as to get used to the unaided responsibility before you cast off moorings."

For ten minutes De Gree was a king in every sense in which it is worth anything to be a king; then a telegram was handed to him:

"Can sell number four Corliss pattern for eighteen hundred dollars—ship September tenth or no sale. Shall I? Telegraph answer.

"SMITH."

Three hundred dollars less than list, but such things had been done; so De Gree told the clerk that he would see about it at once, and then he dived into the shop. Within thirty minutes he found that it would be impossible to finish a No. 4 engine before the 25th unless the shop worked over time. Over time meant "pay and a half" for the men and three-quarters work for the shop. De Gree had found that to be a fact. Figuring upon that basis the chances were that the engine would go out at a loss. Then he went back and told the clerk that the order could not be accepted on the terms stated.

"Will you dictate the answer, Mr. De Gree, or shall I just say that the order is declined?"

"Tell Mr. Smith that we are glad to receive his order, but sorry to be obliged to decline it."

"Would you make any counter offer?"

"Oh, yes, of course; tell him that we can ship the engine on the 25th if that will do."

"Could we not ship another size, say 4½, at the time specified."

"Yes, put that in. Say, write it out and let me see it before it is sent. No, wait a moment!"

De Gree rushed into Blunt's office with the perspiration standing on his face from the unusual exertion and excitement.

"Mr. Blunt! Smith telegraphs that —"

"Let me see the telegram."

"Certainly, sir."

"Let me see—how many fours have we on hand?"

"None, sir."

"Where are they? There were seven built."

"One is here in town at Cut & Try's. Three are in Chicago, one is in Brooklyn, one is in Newark, and —"

"The other one is in the store in New York. Write Mr. Smith—he will get the letter in the morning—that we can ship the engine at once, if necessary, but that our terms to him cannot be changed. Say nothing more. Now this probably will hang fire until I am gone. If Smith can't sell satisfactorily, send Charley Gaul down to help him. He has power to make reductions when they may properly be made."

Late the next afternoon De Gree entered Mr. Blunt's office very thoughtfully.

"Mr. Blunt, I am afraid I don't want to take the whole responsibility of the management in your absence. It makes a difference where a person is responsible and where he is not."

"It does indeed; it means success or failure."

"Could not the works be managed by a committee composed of the heads of the departments and Mr. Gaul? I lose confidence in myself alone."

"No, sir, that committee business means jealousy and fight. There can be but one head. I have given instructions that you are to manage in my absence. I advise, however, that you consult freely with Mr. Gaul on commercial matters, and with the heads of the different departments on all matters connected with their work. The great secret is to guide, so that every man in the place shall push with you and in the same direction. Don't try to do it all, but let the others earn their salaries."

THE mechanical questions discussed by machinists during noon-hours and when they meet outside the shop are not materially different from those which are the subjects of ambitious engineering papers in the leading societies or in the technical journals. Quite frequently subjects that are old shop knots are untied by scientists, and none applaud to a greater degree than the shop-men. Again, a subject which has been practically solved by workmen will be re-solved years afterwards by theorists. The fact that a three-lipped drill in a square bushing will drill an approximately square hole is old lore in Yankee shops, but it was first published about fifteen years ago as an account of an exhibit at the American Institute Fair, I think. English engineers some years later made drill-presses for square holes, the details of which were described in the technical journals. The present writer some years ago formulated the precise data for designing the cams that produce this effect and published it last year in the *Scientific American*. Now, by combinations of these cams, machines to drill many polygons are made. A method of doing this is suggested in a Singer sewing-machine feed movement made thirty years ago. Thus an art is not an invention, but the growth of a germ that is evolved from another growth. Doubtless in the various shops of the world there are many unconsidered trifles that eventually will develop into important arts.

THREE hundred years ago William Shakspere, in speaking of mechanical workmen in different places, called them "rude mechanicals that work for bread" and "hard-handed men that work—which never labored in their minds till now." "What!" he wrote, "know you not, being mechanical, you ought not to walk upon a laboring day without the sign of your profession?" Such expressions show that Shakspere did not know anything about mechanics except the one fact that they performed manual tasks for a living. If he had known them, he would not have said that they did not labor "in their minds." Bottom's trade called for continual study and incessant care, and it took greater mechanical expertness then to produce good cloth with his simple tools than it does to-day, when the looms are automatic and require no great operative skill. Good cloth was made whether in England in the year 1600, or in Greece two thousand years earlier. Quince and Snug, carpenters and joiners, were Englishmen. The house wherein Shakspere was born and where he lived in his youth is an excellent piece of carpentry and joinery, and could not have been built without mind labor of a great degree of excellence. The mechanics whom the great poet selected for his characters were those whose work was in evidence at the time of the writing. The room and house he wrote in suggested the carpenter and joiner, his clothing the weaver and tailor, and the furniture about his hearth the bellows-mender and tinker. Practically he knew nothing of these crafts except an occasional interview with a tailor and perhaps a scene or two with a tinker and a bellows-mender,—the three most debased types of workmen, then as now. Shakspere's mechanical remarks have for us this value only; they furnish data by which we can measure the rise of the mechanical trades in respectful consideration during three hundred years. He, however, in his infinite observation, saw the progress of equality, as this quotation proves: "By the Lord, Horatio, these three years I have taken note of it; the age is grown so picked * that the toe of the peasant comes so near the heel of the courtier that he galls his kibe." †

NO mechanical movement on the surface is more attractive than the worm and gear. As a means to reduce speed greatly in one motion it is an unparalleled device, but as a means to correspondingly gain power it is a delusion and a snare. No one must calculate on it as equivalent to a train of gears, for it has no element of gearing about it. It is a screw and a nut on a lever, and nothing else. It consumes power and produces friction to as great a degree as a vise or any other form of screw

* Smart. † Chilblain.

and nut under great duty. If an illustration of the power lost by the use of worms be required, take an old-fashioned elevator that is run by belts which drive pulleys on a worm-shaft, the elevator cage having its cables attached to a drum on the shaft that is driven by the worm-gear. Find out experimentally how many pounds at most that elevator with itself and cable added can lift, and multiply that by as many feet as it is lifted each minute. Divide by 33,000 to find the horse-power developed in the worm-gear. To measure the power that goes into the worm a dynamometer must be employed. This formidable name may describe a very crude and simple device. There certainly could be none much cruder than the following, though for the purpose none could be better: Bolt to the side of the driving pulley on the worm-shaft a scantling that produces an arm more than ten radii of the pulley out from the center of the shaft. This scantling must be arranged so that the action of the driving-belt depresses its outer end. Under that outer end place a platform scale and connect it to the arm by a stiff rod. This rod must be placed at a point under the scantling precisely ten radii of the pulley from the shaft. It must stand vertically, on the center of the platform of the scale, and the scantling must be so placed that the top end of the rod is horizontally opposite the center of the shaft. With the descending belt off entirely, and the driving belt on the loose pulley, the weight of the scantling and of the rod on the scale should be found and noted. Then the driving belt should be shipped upon the driving pulley, held there, and permitted to slip while the friction produced by the slipping is weighed on the scale. The power of the belt will of course be ten times the weight indicated on the scale after the weight of the scantling and rod is subtracted. Multiply this pull of the belt by the number of feet it travels each minute; the result divided by 33,000 shows the horse-power that the worm receives. The difference between this horse-power and that which at most the elevator cable can lift is lost in friction in the worm gear, except a minute fraction. It is believed that this dynamometer by its direct method actually weighs all the power a belt transmits, and it requires no involved calculations to get the results or skill to understand it.

The writer knows of cases where the spindles of milling machines had been worm geared for power and the desired results were not obtained; but when afterward they were remodeled to be driven by a train of spur wheels they had power to spare. Designers of machinery who have not had occasion to use worm gears to much extent or for heavy duty will do well to investigate their merits before admitting them to service in important positions.

EIGHTEEN years ago I was employed in a telegraph-instrument shop in Chicago. Within that shop was a Frenchman who, on the whole, was a very pleasant fellow. He had strong Communistic principles, but did not look at things quite as consistently as even we Americans do. He always did the "dipping,"—that is, cleaning yellow brass rough work by dipping it in acid. He had a special mixture for that purpose, which gave the brightest of effects, but of which no one but he knew the composition. Once I asked him what the proportions of his dipping-bath were.

"That is my art," said he.

I could have found the "art" by weighing the carboys before and after his abstractions of acids, but I questioned my right to do it. Had I that right?

AS far as my art has revealed her processes to me, they are of public knowledge, and I have but little faith in the power to keep manufacturing processes secret. The patent laws furnish a means, more or less adequate, by which discoveries may be protected, and all art "secrets" having value should be recorded under these laws. Still, if an art or a process were kept secret, it would be a much simpler thing to handle than a patented one, and this would be the preferable method of retaining such property if it were not a fact that the secret, once known, becomes public property, provided its product has been two years or more on sale, and therefore cannot be patented.

CURRENT TECHNICAL LITERATURE.

TO THE READER.—This catalogue is compiled from the technical periodicals of the United States, England and France. If you were to subscribe only for those of most importance, it would cost you over $500.00 a year. If you were to undertake to read them, you would do nothing else from year's end to year's end. To subscribe for THE ENGINEERING MAGAZINE and get the benefit of this catalogue costs you but $3 a year. To glance over those departments of the catalogue in which you are chiefly interested, and decide which of the articles listed are of real value to you, requires but fifteen minutes of your time each month. If you have taken the precaution to purchase a stock of our coupons, it will take you but ten minutes more to fill out, say a dozen, and enclose them in an envelope to THE ENGINEERING MAGAZINE COMPANY, WORLD BUILDING, NEW YORK. No letter-writing is required. A stamped envelope does the work. In return you will receive the dozen articles desired, though they may be published at a dozen different points in the world.

The articles should be ordered *by number*, not by title alone. The prices are 15, 30, and 45 cents. Articles at 30 cents are indicated by an asterisk (*), those at 45 cents by a dagger (†). Coupons, with blanks for the number of the article and the purchaser's address, are furnished at 15 cents each, or $1 for 7, $5 for 35, and $12.50 for 100. Each coupon is receivable in exchange for a 15-cent article. Two coupons must be sent for a 30-cent article, and three for a 45-cent article. All orders *must* be accompanied by cash or coupons. English and French patrons will confer a favor by remitting English or French postage stamps of small denominations.

In the body of the index the initials of the papers quoted are given, and these can be readily identified by the alphabetical list of periodicals below. Other abbreviations are: Ill=Illustrated; w=words.

THE AMERICAN PRESS.

A S .....Age of Steel. *w.* $3. St. Louis.
A An.... American Analyst. *f.* $1 per year. N. Y.
A A.....American Architect. *w.* $6. Boston.
A Ar.....American Artisan. *w.* $2. Chicago.
A C J....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D .....American Druggist. *m.* $1.50. New York.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
A G .....Am. Geologist. *m.* $3.50. Minneapolis.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..American Journal of Railway Appliances. *m.* $2 per year. New York.
A M .....American Machinist. *w.* $3. New York.
A M & I W.American Manufacturer and Iron World. *w.* $4 per year. Pittsburg.
Am M....American Miller. *m.* $2. Chicago.
Am S....American Shipbuilder. *w.* $2. N. Y.
A A A....Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A H.....Annals of Hygiene. *m.* $2 per year. Phila.
A E .....Architectural Era. *m.* $3. N. Y.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A & B....Architecture and Building. *w.* $6 N. Y.
A .....Arena. *m.* $5 per year. Boston.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
At M.....Atlantic Monthly. *m.* $4 per year. Boston.
B J C....Boston Journal of Commerce *w.* $3 per year. Boston.
B & W...Builder and Woodworker. *m.* $1. N. Y.
B P .....Bulletin of Pharmacy. *m.* $1. Detroit.
C A.....Calif. Architect. *m.* $3. San Francisco.
C E N....Canadian Electrical News. *m.* $1 per year. Toronto.
C & B... Carpentry and Building. *m.* $1. New York.
C M.....Century Magazine. *m.* $4 per year. N. Y.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C E. .....Colliery Engineer. *m.* $2. Scranton, Pa.
C..... .Compass. *m.* $2 per year. New York.
Cos..... .Cosmopolitan. *m.* $3 per year. New York.
Cr .....Crank. *m.* $1.25 per year. Ithaca, N. Y.
D E.....Domestic Engineering. *m.* $1. Chicago.
D J.....Drainage Journal. *m.* $1. Indianapolis.
D Jour. .Druggists' Journal. *m.* $1. Chicago.
E A .....Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3 per year. N. Y.
E I.....Electrical Industries. *m.* $3. Chicago.
E R N Y..Electrical Review. *w.* $3 per year. N. Y.
E W .....Electrical World. *w.* $3 per year. N. Y.
E N Y....Electricity. *w.* $2.50. N. Y.
E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
Eng .....Engineer. *s-m.* $2 per year. New York.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M.....Engineering Mechanics. *m.* $2. Phila.
E N .....Engineering News *w.* $5 per year. N. Y.
F & M R..Financial and Mining Record. *w.* $3. N.Y.
F W .....Fire and Water. *w.* $3 per year. N. Y.
F .....Forum. *m.* $5 per year. New York.
G & F....Garden and Forest. *w.* $4 per year. N.Y.
G G M...Goldthwaite's Geographical Magazine. *m.* $2 per year. N. Y.
G R.....Good Roads. *m.* $2 per year. N. Y.
I A .....Inland Architect. *m* $5 per year. Chicago.
I R W...India Rubber World. *m.* $3 per year. N.Y.
I S F.....Industry. *m.* $2 per year. San Francisco.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age...Iron Age. *w.* $4.50. N. Y.
I T R ...Iron Trade Review. *w.* $3. Cleveland.
J A C S...Journal of the American Chemical Society. *m.* $5 per year. N. Y.
J A E S...Journal of the Association of Engineering Societies. *m.* $3 per year. Chicago.
J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J M S I...Journal of the Military Service Institution. *b-m.* $4 per year. Governor's Island, N. Y. H.
J N E W..Journal of the N. E. Waterworks Association. *q.* $2. New London, Conn.
L M.....Leather Manufacturer. *m.* $3. N. Y.
L E.....Locomotive Engineering. *m.* $2. N. Y.
M & B... Manufacturer and Builder. *m.* $1.50. N. Y.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M N.....Mechanical News. *s-m.* $1.50. New York.
M & El...Mechanic and Electrician. *w.* $2 per year. St. Louis.
Met W...Metal Worker. *w.* $2 per year. N. Y.
Min.....Minerals. *m.* $1 per year. N. Y.
M S P... Mining and Scientific Press. *w.* $3 per year. San Francisco, Cal.
M S R....Mining and Scientific Review. *w.* $2 per year. Denver.
M I T....Mining Industry and Tradesman. *w.* $3 per year. Denver.
Misc.....Miscellaneous.
N B .....National Builder. *m.* $3. Chicago.
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N A R...North American Review. *m.* $5. N. Y
N W.....Northwestern Architect. *m.* $3. Minneapolis.
N M. ....Northwestern Mechanic. *m.* $1. Minneapolis.
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Sea.....Seaboard. *w.* $2 per year. N. Y.
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S.....Stone. *m.* $2 per year. Indianapolis, Ind.
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T Q.....Technology Quarterly. $2. Boston.
T.....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Transactions American Institute of Electrical Engineers. *m.* $5 per year. N. Y.
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R W ....Railway World. *m.* 8*3*, post-paid. London.
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*6343. Storage Traction Finance. Editorial (E E L–Aug. 19.) 1500 w.

*6366. The Schuckert Rotary Field Motor. Ill. (E R L–Aug. 19.) 2500 w.

†6372. The Electric Transmission of Power. Ill. Eugene Griffin (J F I–Sept.) 6000 w.

6374. Light and Power Stations. Ill. VI. Robb Mackie (E R N Y–Sept. 10.) 600 w.

6379. Some Views of Central Station Work. XXV. T. Carpenter Smith (E N Y–Sept. 7.) 1500 w.

6384. Comparative Cost of Horses and Electricity in Country Work. William Nelson Black (E W–Sept. 10.) 2000 w.

*6399. On the Clark Cell. Dr. Kahle (E R L–Aug. 26.) 1500 w.

*6400. Wave Propagation in Magnetic Materials. Prof. Fitzgerald (E R L–Aug. 26.) 600 w.

*6407. On a Magnetic Balance and its Practical Use. Ill. H. E. J. G. Du Bois (El–Aug. 26.) 1000 w.

*6408. On the Physics of the Voltaic Arc. Silvanus Thompson (El–Aug. 26.) 900 w.

*6410. Electrical Units. Sydney Evershed and Ernest B. Vignoles (El-Aug. 26.) 500 w.

*6427. A Battery Problem. Ill. (E E L-Aug. 26.) 800 w.

*6438. Propagation of Magnetic Impulses along a Bar of Iron. V. A. Julius (N-Aug. 25.) 500 w.

*6445. Notes on Bell-fitting. (E L-Aug. 26.) 2500 w.

6461. A Few Practical Observations on Covered Wire Making and Using. Frederic A. C. Perrine (E E N Y-Sept. 7.) 1500 w.

6462. Theoretical Elements of Electro-Dynamic Machinery. XII. Ill. A. E. Kennelly (E E N Y-Sept. 7.) 1200 w.

6463. Direction of Electric Movement. Philip Atkinson (E E N Y-Sept. 7.) 1400 w.

6464. Insulated Electric Conductors. IX. James Bowstead Williams (E E N Y-Sept. 7.) 900 w.

6465. Auroral and Earth Currents. D. B. Grandy (E E N Y-Sept. 7.) 500 w.

*6491. The Future of Electrical Power Transmission. Editorial (I L-Sept. 2.) 1200 w.

*6493. Running Alternators in Parallel. (I L-Sept. 2.) 2700 w.

*6517. Transformers. John Perry (El-Sept. 2.) 3500 w.

*6524. The Effect of Friction upon the Exactitude of Electric Meters. G. P. Roux (E E L-Sept. 2.) 2500 w.

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6554. A Portable Instrument for Measuring Magnetic Fields, with Some Observations on the Strength of the Stray Fields of Dynamos. Ill. Edwin Edser and Herbert Stansfield (E W-Sept. 17.) 800 w.

6560. Light and Power Stations. VII. Robb Mackie (E R N Y-Sept. 17.) 700 w.

6561. Power Transmission by Alternating Current. Ill. Gisbert Kapp (E R N Y-Sept. 17.) 1400 w.

6562. Shall We Erect Lightning Rods? Alexander McAdie (E R N Y-Sept. 17.) 2500 w.

*6564. Emploi des Accumulateurs comme Régulateurs. Ill. E. M. (El P-Aug. 28.) 1500 w.

*6570. Les Applications Calorifiques de l'Electricité. Ill. (Elec-Aug. 18.) 2400 w.

*6571. Préparation Electrolytique des Alcalis et des Carbonates Alcalins. Ill. (Elec-Aug. 18.) 900 w.

*6572. Avertisseurs et Indicateurs Electriques. Ill. I. (Elec-Aug. 25.) 2000 w.

*6573. Ventilation des Canalisations Souterraines d'Electricité. Ill. M. Monmerqué (Elec-Aug. 25.) 900 w.

*6575. Avertisseurs et Indicateurs Electriques. Ill. II. (Elec-Sept. 1.) 3100 w.

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5922. Electric Lighting in England. H. Scholey (E E N Y-Aug. 10.) 1400 w.

5923. The Blackening of Incandescent Lamps. E. C. Cary (E E N Y-Aug. 10.) 900 w.

5924. The New Station of the Edison Electric Illuminating Company of Boston. Ill. A. C. Shaw (E E N Y-Aug. 10.) 8000 w.

5928. High Voltage Incandescent Lamps. A. de Khotinsky (E E N Y-Aug. 17.) 1000 w.

5930. Metallic *vs.* Mercury Pumps for Exhausting Incandescent Lamps. A. L. Reinman (E E N Y-Aug. 17.) 900 w.

5934. Diving for Treasure at Hell Gate. Ill. Geo. B. Muldaur (E E N Y-Aug. 24.) 600 w.

5935. The Modern Electric Search Light. Ill. E. R. Knowles (E E N Y-Aug. 24.) 1400 w.

5936. The Central Station of the Concord Gas Light Company at Concord, N. H. Ill. A. C. Shaw (E E N Y-Aug. 24.) 1200 w.

*5947. The Application of Destructors, Particularly to the Electric Lighting of Edinburgh (E R L-Aug. 12.) 1300 w.

*5951. Incandescent Lamp Manufacture and Tests. C. J. Robertson (E R L-Aug. 12.) 1600 w.

*5980. La Croix Electrique de l'Eglise du Sacré-Cœur. Ill. (Elec-Aug. 4.) 1100 w.

*5982. Perfectionnements Relatifs à Incandescence. Ill. (Elec-Aug. 11.) 2400 w.

*5984. Hints About House Wiring. A. H. Gibbings (E L-Aug. 5.) 1000 w.

*5985. The Electric Lighting of Railway Carriages. Ill. (E L-Aug. 5.) 1700 w.

*5986. Testing House Circuits. A. H. Gibbings (E L-Aug. 5.) 1000 w.

*6132. L'Eclairage Electrique de l'Ecole Militaire de Saint-Cyr. Ill. J. A. Montpellier (G C-Aug. 13.) 2400 w.

6266. Electric Light Wiring of Houses and Buildings. F. C. Cartwright (E R N Y-Sept. 3.) 1000 w.

6308. A Long Distance Transmission Plant between Tivoli and Rome. Ill. (E W-Sept. 3.) 1000 w.

*6344. Cardiff Electric Lighting (E E L-Aug. 19.) 3500 w.

*6360. Testing House Circuits. II. A. H. Gibbings (E L-Aug. 19.) 1200 w.

6383. Efficiency Test of a Brush-Swan Electric Light Station. Frederick Bedell (E W-Sept. 10.) 1800 w.

*6523. Light and Power. Arthur F. Guy (E E L-Sept. 2.) 1700 w.

6548. Electric Lights for Astronomical Instruments. Ill. Jefferson E. Kershner (E N Y-Sept. 14.) 1700 w.

6551. On the Physics of the Voltaic Arc. Sylvanus Thompson (E N Y-Sept. 14.) 1000 w.

6552. Life and Efficiency Tests on Incandescent Lamps, with a Formula for Determining the Relative Values of the Different Makes of Lamps. Ill. P. G. Gossler (E W-Sept. 17.) 3500 w.

*6566. Lampe à Arc Différentielle de la Maison Sautter, Harlé et Cie. Ill. J. A. Montpellier (El P–Aug. 27.) 900 w.

*6568. Nouvelle Lampe à Arc à Potentiel Constant de M. Bardon. Ill. Em. Dieudonné (El P–Sept. 3.) 1200 w.

*6574. L'Electricité au Théatre. F. Géraldy (Elec–Sept. 1.) 2100 w.

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6029. Dawson Water Gas for Gas Engines. (E M J–Aug. 20.) 1100 w.

6060. Fuel Gas. K. M. Mitchell (A A–Aug. 13.) 2200 w.

6066. The Askins Apparatus for the Manufacture of Gas. Description from the specifications, and report of A. B. Cornell and W. A. Ross on the Results at Bellefontaine, Ohio. Ill. (A G L J–Aug. 22.) 4200 w.

6067. Coal Analysis. John McRae (A G L J–Aug. 22.) 2200 w.

*6114. Chemistry and the Gas Industry. C. E. Jones (G E M–Aug. 10.) 1500 w.

*6115. Enriching Coal Gas by Paraffin Oil or Liquid Hydrocarbons. J. Mackay (G W–Aug. 6.) 4200 w.

*6116. President's Address Before the North of Ireland Association of Gas Managers. W. S. Stormonth (G W–Aug. 13.) 3500 w.

*6238. The Birmingham Fuel Gas Project. B. H. Thwaite (J G L–Aug. 2.) 2500 w.

*6239. On Gasholders Without Upper Guide-Framing. I. W. Gadd (J G L–Aug. 9.) 3000 w.

*6240. How to Keep Down Complaints and Grumbling Amongst Consumers. Geo. Keillor (J G L–Aug. 9.) 2500 w.

*6241. Sudden Excesses of Sulphur in Connection with Lime Purification, and their Remedy. J. Robb (J G L–Aug. 16.) 2500 w.

*6242. The Explosion of Ethylene with Less than its Own Volume of Oxygen. Messrs. Lean and Bone (J G L–Aug. 16.) 500 w.

*6243. Notes on the Luminosity of Hydrocarbon Flames. Prof. Lewes (J G L–Aug. 16.) 3800 w.

*6244. Inaugural Address of Prof. Emerson Reynolds. I. (J G L–Aug. 16.) 3000 w.

*6245. "Smokeless London." Lynn Cyril D'Oyle (J G L–Aug. 16.) 2000 w.

*6257. The Price of Gas, and Gas Stoves. (J G L–Aug. 23.) 2000 w.

*6258. Shall We Utilize the Latent Abilities of the Managers and Workmen Engaged in Gas Works? Gilbert Little (J G L–Aug. 23.) 2000 w.

*6259. On the Value of the Bye-Products of Gas Works, and on Improved Methods of Estimating Them. Chas. R. C. Tichborne (J G L–Aug. 23.) 2000 w.

*6260. Inaugural Address of Prof. Emerson Reynolds. II. (J G L–Aug. 23.) 4300 w.

*6323. The Berthelot-Mahler Calorimeter. Ill. (G W–Aug. 20.) 1200 w.

6329. Sulphocyanic Acid and the Sulphocyanids in the Manufacture of Illuminating Gas. Herman Poole (A G L J–Aug. 29.) 2400 w.

*6439. The French Société Technique. M. Edouard Melou (G W–Aug. 27.) 2000 w.

*6482. The Behavior of Oxygen when Air is Used in the Purification of Coal Gas. Thos. Stenhouse (J G L–Aug. 30.) 1600 w.

*6520. The Production of Heating Gas and Ammonia. A. Hennin (C T J–Sept. 3.) 1200 w.

*6595. A Criticism of Street Lamps (J G L–Sept. 6.) 2000 w.

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6045. The Vyrnwy Water Supply for Liverpool. Ill. Editorial (E N–Aug. 18.) 2500 w.

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6107. The Arrangement of Hydrants and Water Pipes for the Protection of a City Against Fire. IV. Ill. (F W–Aug. 20.) 1600 w.

6108. Ideas on Fire Protection. S. P. Axtell (F W–Aug. 20.) 1300 w.

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*6125. Reservoir d'Eau de Mannheim. Ill. T. C. H. (G C–Aug. 6.) 1000 w.

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*6316. Condensers and Pumps. Ill. Geipel and Kilgour (El–Aug. 19.) 3000 w.

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*6405. The London Water Supply. Editorial (I L–Aug. 26.) 1800 w.

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Properties. W. H. Edgar (S E–Aug. 13.) 2000 w.

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*6014. The British Battle-Ship "Ramillies." Ill. (E–Aug. 12.) 1300 w.

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*6315. United States Cruiser No. 12—The Columbia. Ill. (Eng L–Aug. 19.) 2400 w.

*6322. The "Daily Graphic" Prize Grapnel. Ill. (Inv–Aug. 20.) 800 w.

*6412. Watertight Sub-division of Ships. II. (M W–Aug. 26.) 800 w.

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*6527. Steel Screw Tug-Boats. Ill. (Eng L–Sept. 2.) 1400 w.

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*6576. Les Torpilles. "El" (M I–Aug. 9.) 2500 w.

*6583. Emploi de la Vapeur Surchauffée dans la Marine (M I–Aug. 23.) 6000 w.

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*5949. Anti-Friction Materials for Bearings Used Without Lubricants. Killingworth Hedges (E R L–Aug. 12.) 2500 w.

*6006. Brake Horse-Power. Ill. Y. and C. E. B. (Eng L–Aug. 12.) 3700 w.

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*6018. Water Meters for Engine Trials. Editorial (E–Aug. 12.) 1100 w.

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6075. Sperry's Micrometer Scale (A M–Aug. 18.) 900 w.

*6119. Moteur à Vapeur Perfectionée à Allure Rapide, Système Locoge et Rochart. F. Desquiens (G C–July 30.) 1500 w.

*6120. Elévateur à Grains, Système Bruno Rostand. Ill. Henri Mamy (G C–July 30.) 700 w.

*6121. Coussinets Demi-Liquides, Système Dynkoff. Ill. Max de Nansouty (G C–July 30.) 1400 w.

*6127. Le Cyclone. Nouvelle Bicyclette sans chaîne à engrenages multiplicateurs. Ill. Max de Nansouty (G C–Aug. 6.) 1500 w.

*6150. The Linde Ice-Works and Cold Stores. Ill. (I–Aug. 5.) 2300 w.

*6163. A New Process of Welding Boiler Shells by Machinery (Inv–Aug. 13.) 1650 w.

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†6246. Tortuosity. I. (I E–July 30.) 2800 w.

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6290. The Cyclone Pulverizer. Ill. Axel Sahlin (M R–Sept. 2.) 1400 w.

*6291. The Pantograph. Ill. (C–Sept.) 1000 w.

*6334. Lathe for Rose Turning. Ill. (E–Aug. 19.) 2000 w.

*6367. Water Power. I. Ill. E. Tremlett Carter (E R L–Aug. 19.) 2800 w.

6377. Leather Belting. (E N Y–Sept. 7.) 1100 w.

*6381. Speed and Safety. C. R. Tompkins (Am M–Sept. 1.) 1000 w.

6392. Automatic Machinery. B. F. Spalding (A S–Sept. 3.) 2000 w.

*6396. Water Power. II. Ill. E. Tremlett Carter (E R L–Aug. 26.) 1800 w.

*6402. The Graphic Determination of Piston Acceleration. Ill. Dr. Kirsch (I L–Aug. 26.) 800 w.

*6409. Second Report on the Development of Graphic Methods in Mechanical Science. H. S. Hele-Shaw (El–Aug. 26.) 1500 w.

*6411. Machine Construction. II. Ill. (M W–Aug. 26.) 400 w.

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*6525. Water Power. III. E. Tremlett Carter (E R L–Sept. 2.) 2000 w.

*6588. Dynamomètre de Rotation, Système Ch. Frémont. Ill. F. Desquiens (G C–Aug. 20.) 1200 w.

*6592. Apparéil de Levage à Six Tambours. Ill. T. C. H. (G C–Aug. 27.) 600 w.

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6604. Practical Details of Die-sinking. I. Ill. B. F. Spalding (A M–Sept. 15.) 1800 w.

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5960. Electro-Metallurgy. IX. F. M. F. Cazin (E W–Aug. 13.) 2600 w.

5967. Electro-Metallurgy. X. F. M. F. Cazin (E W–Aug. 20.) 1500 w.

*5973. Industrial Electrolysis. Editorial (El–Aug. 5) 2000 w.

*5975. La Couplage en Série des Machines de Haute Tension à Courant Continu. E. Meylan (El P–Aug. 6.) 1100 w.

*6015. The Zeehan and Dundas Smelting Works. Ill. (E–Aug. 12.) 800 w.

6022. The McArthur-Forest Patents. E. Dwight Kendall (E M J–Aug. 13.) 1000 w.

6030. The Determination of Zinc in Ores (E M J–Aug. 20.) 1200 w.

6033. Variations in the Milling of Gold Ores Ill. I. T. A. Rickard (E M J–Aug. 27.) 2300 w.

6076. Melting Cast-Iron in Reverberatory Furnaces. S. Bolland (A M–Aug. 18.) 2400 w.

*6100. Improvements in the Reduction of Ores. T. Shoanberger and Blair, Jr. (C G–Aug. 12.) 1100 w.

*6151. The Detection and Estimation of Minute Quantities of Lead in the Presence of Copper and Iron. Frank L. Teed (I–Aug. 12.) 1300 w.

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6168 The Cyanide Process. A Chemical View of It. M. T. (M S P–Aug. 20.) 750 w.

6205. The Manufacture of Russia Sheet-Iron. Ivan Stephanowich (R & T–Aug.) 800 w.

6233. The Hastings Steel Process. Geo. W. Ware (M R–Aug. 19.) 1000 w.

6295. Our Tin-Plate Mills (Met W–Sept. 3.) 5500 w.

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6303. Calculation of Charge for the Lead Blast Furnace. H. O. Hofman (E M J–Sept. 3.) 2000 w.

6311. Electro-Metallurgy. XI. F. M. F. Cazin (E W–Sept. 3.) 1000 w.

6319. Virginia as a Basic Steel Maker. Edmund C. Pechin (I T R–Aug. 25.) 1500 w.

6352. Ferro-Manganese Manufacture in the South. James M. Couper (A M & I W–Aug. 26.) 1200 w.

*6354. Metallurgical and Mining Statistics for Russia in 1889 (I–Aug. 19.) 400 w.

*6357. Magnetic Separation of Zinc Ores. E. Ferraris (I–Aug. 19.) 900 w.

6386. Electro Metallurgy. XII. F. M. F. Cazin (E W–Sept. 10.) 1500 w.

6422. The Decadence of the Forge. Editorial (A M & I W–Sept. 2.) 900 w.

*6424. Recovering Metallic Iron from Slag. Walter J. May (C G–Aug. 26.) 1200 w.

*6425. Manufacture of Pig Iron in Luxemburg and the Rhine Provinces. M. G. Bresson (C G–Aug. 26.) 3000 w.

*6426. Malleable Pig (C G–Aug. 26.) 1000 w.

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*5998. Explosions and Boiler Insurance. Editorial (Eng L–Aug. 5.) 1100 w.

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5994. Submarine Cable Reminiscences. II. Herbert Laws Webb (E N Y–Aug. 24.) 1900 w.

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COMMENT & CRITICISM.

The Ropes' Pass Enterprise.

IT is impossible for an editor to detect in every case, the object of a writer in describing an enterprise in a distant part of the country, and on that account I am not surprised at the appearance in your pages of Mr. Kent's recent article entitled "Engineering at Ropes' Pass." I am thoroughly familiar with the various schemes of harbor improvement that have been undertaken on the Texas coast, and I am satisfied that no capitalist will regret making a thorough investigation before sinking money in those gilt-edged opportunities for investment.

Of all the attempts that have been made, both by the general Government and by private companies, to establish a deep-water port on the Texas coast, only one, so far, has been carried sufficiently near completion to give any promise of success; and even that has now been left so long in an unfinished condition that investors have but little confidence in the final outcome of the enterprise. Mr. Kent tells the readers of THE ENGINEERING MAGAZINE that Colonel Ropes organized a company which has now been at work for about a year cutting the channel from Corpus Christi Bay to the Gulf. The writer recollects seeing this so-called channel nearly *two* years ago, and also of seeing town lots sold at Corpus Christi for fancy prices on the strength of the statements made that a deep-water port would be completed there in a few months' time.

The toy jetties, (20 feet long, 4 feet wide, and 5 feet high) which Mr. Kent describes, compare well with the toy channel that has been cut across Mustang Island; and the engineer who inspects this work can but come to the conclusion that, if it is to be palmed off on the public as a specimen of American harbor engineering, the Government engineers who have lately been so justly criticised in this magazine may well feel proud of their achievements. Mr. Kent states that "it is expected that a few months more will witness the formal opening of this important outlet to commerce." This sounds strangely familiar to those conversant with the advertising literature of the Gulf coast, and when we consider that two years have been spent in cutting a mere ditch across the island, the professional reader may well be pardoned for being somewhat skeptical.

The writer does not wish to be understood as questioning what can or cannot be done at Ropes' Pass, or elsewhere on that Coast; but I wish to state decidedly that, until more real engineering is done at the proposed harbor sites and less in magazines, the public can well afford to allow present holders to reap the rich rewards that are promised by alluring town-lot investments in cities near by.

A TEXAN.

American Towns.

IN all the great cities of Europe, Great Britain, and America the past few years have been remarkable for the rapid improvement in methods and facilities for traveling. In the United States especially, where a sparse population is distributed over a large and fertile region of the earth, there appears to be no reasonable cause for overcrowded cities and towns. The use of larger areas within corporation lines: the adoption of larger home lots beautified with fruits and flowers, cultivated by the members of the family; the subdivision of land into small well-cultivated tracts of a few acres in extent; and the extension of street railways carrying people away from crowded centers, far out to suburban retreats where they enjoy fresh air and wholesome exercise,—have produced a marked improvement in the habits and tastes of the industrious and progressive portion of the people.

At this era in our national history it would be an error ominous of the future degeneracy in the habits and physical well-being of the race to overcrowd the town and leave a fertile country deserted, despised, and neglected. The expansion of the town limits would bring into use and occupancy large areas of land now of little value, the improvement of which according to the rules of Modern Landscape Gardening would give employment to thousands, and result to them in health and elevation of mental tone. The proper distribution of buildings should be made to counteract the tendency to crowd all business and public buildings toward one center,—a tendency that until the era of rapid transit held an undisputed supremacy. The rapid increase in the expenses of city improvement in the engineering work has created some alarm amongst property owners in many of our American towns.

The tendency to overload some central areas of land in our cities with enormous buildings erected with some skill at great cost is being counteracted by the increased and popular improvements in methods of traveling or transportation. A taste for architecture would find enlarged scope for exercise, not in towns where the buildings were overcrowded, but where the principle of extension dominated. In fact, the tendency in all large buildings is to subordinate everything—taste, safety, and expediency—to size. A correct taste in architecture, especially in domestic buildings, would produce many suburban homes in which due proportion and chaste ornamentation would be displayed. In the rapid extension of town limits therefore there is much to be expected, not only in an improved taste, but in opportunity also.

The improvement in building materials is only beginning; hitherto, the abundance of wood and the neglect of stone have given little variety to smaller buildings, and in this kind of construction there is much expectation of future development. The Arts and Sciences may in the coming era of our national development find many applications in domestic life.

WILLIAM CLAYPOOLE.

Springfield, Ohio, August 4, 1892.

A Card From General Haupt.

THE publication in a Chicago paper of my article on the Pneumatic Motor which appeared in this magazine for August requires a word of explanation.

I made two copies, one of which was sent to my son, Professor Haupt, with authority to have it published. The other I sent to a friend in New York, formerly interested in the motor of 1879, simply for his information, with no instructions to publish it and no expectation that he would use it in that way. This gentleman, it appears, without advising me, sent it to Chicago, not knowing that I had authorized its publication elsewhere.

H. HAUPT.

St. Paul, Minn., September 5, 1892.